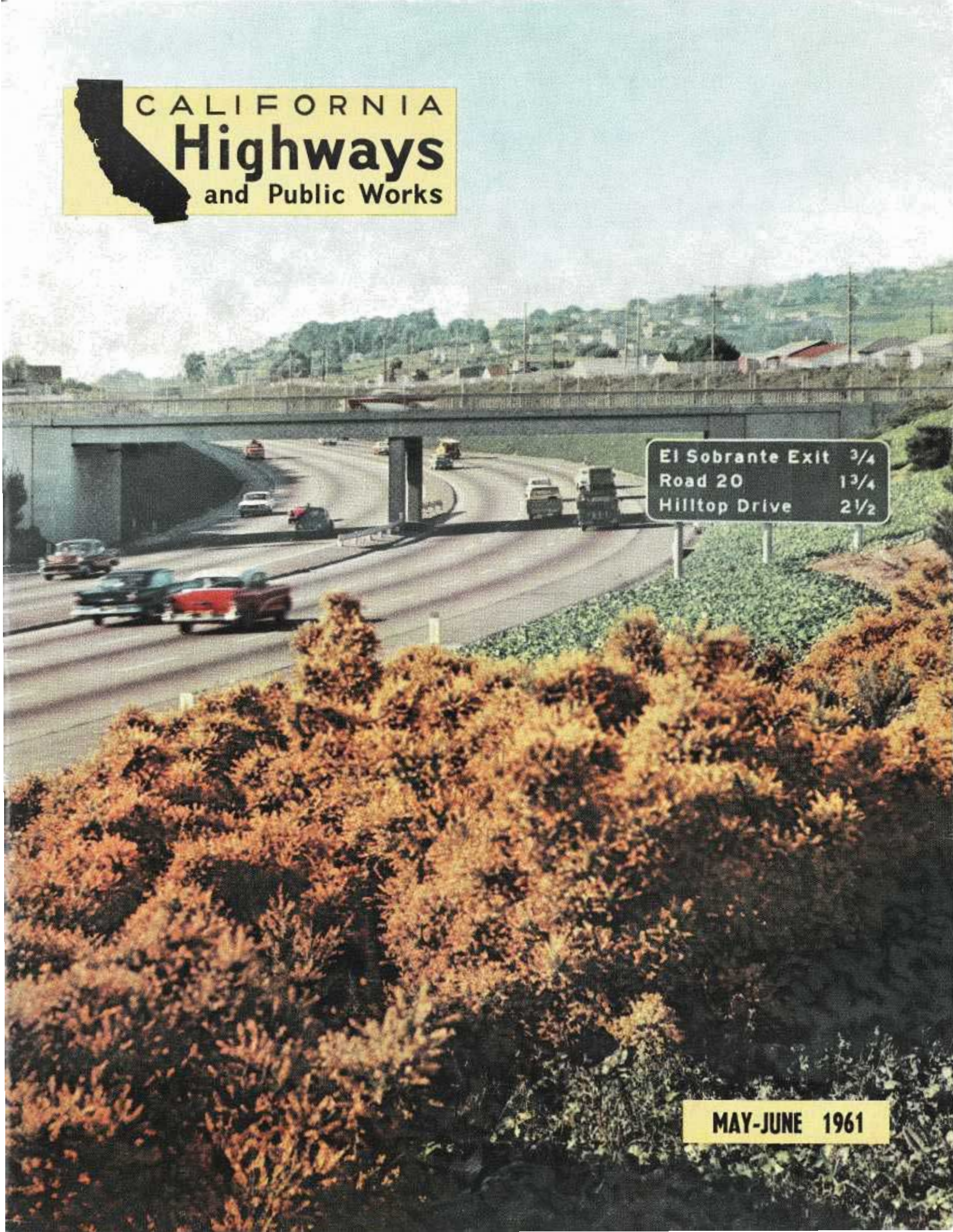
CALIFORNIA Highways and Public Works



MAY-JUNE 1961

National Highway Week Observed

THE WEEK of May 21-27, 1961, was observed throughout the United States as National Highway Week.

The observance was made official by virtue of a proclamation issued by President John F. Kennedy, in which he called attention to the importance of completing the National Interstate System of Interstate and Defense Highways on schedule in 1972 and pointed out that "The orderly advancement of our expanded Federal-State highway program promises a sharp reduction in our annual waste of human and economic resources due to outmoded highways."

In California, Governor Edmund G. Brown also cited the contribution of better highways to the public safety and economic growth *(see statement)*.

The observance was given added significance in California by virtue of this year's being the 50th anniversary year of this State's modern-day highway program. The California Highway Commission was created in 1911.

Newspapers throughout the state carried accounts of recent and current construction progress in modern highway construction, with emphasis on Interstate System and other freeways.

State Highway Engineer J. C. Womack was quoted as noting that California has increased its total of multi-lane divided highways by nearly 1,000 miles in the past six years. The State now has approximately 2,300 miles of multi-lane divided highways in operation now. Most of the recent construction has been of the full freeway or expressway type.

Womack also pointed to the progress in highway planning, as evidenced by the pace of freeway route adoption actions by the California Highway Commission. The Commission has now adopted routes for 5,560 miles of controlled access freeways and expressways, an increase of 2,670 miles in six years.

STATEMENT

The demands of a growing and mobile economy, the interests of national defense and the urgent need to relieve the suffering caused by accidents are constant pressures for better highways to serve our nation.

In California, we are meeting these challenges by building thousands of miles of freeways and expressways and by improving roads that are no longer adequate to the burdens placed upon them.

President John F. Kennedy has proclaimed the week of May 21-27 as National Highway Week in recognition of the vital role our highways play in the continued growth and prosperity of America.

As Governor, I urge all Californians to share in the observance of this week. I urge also that we take this opportunity to pay tribute to the thousands of engineers, contractors and construction workers who work so hard to keep America on the move.

Edmund G. Brown

EDMUND G. BROWN, Governor

In some parts of the state, notably Southern California, interested organizations sponsored special events. Undersecretary of Commerce Clarence D. Martin, Jr. spoke at a luncheon in Los Angeles, and a dedication ceremony was held for a completed portion of the East Los Angeles Interchange now under construction. A special television program featured the proceedings at a public meeting in Escondido regarding freeway route location studies in that area.

A number of newspapers ran special articles on highway developments in their respective areas of the state. The Oakland *Tribune* featured a series of National Highway Week articles by its highway specialist, Dave Hope.

Part of the observance of National Highway Week was a dedication ceremony signalizing the opening to traffic on a portion of the East Los Angeles Interchange on May 23. Highway Commissioner Roger S. Woolley is shown speaking. Behind him is former Highway Commissioner Harrison R. Baker, president of the Los Angeles Metropolitan Traffic Association. At far left, with notes in hand, is Highway Commissioner Robert E. McClure, accompanied by District Engineer A. L. Himelhoch of District VII.

The trucks in the background are using the newly-opened ramp connection from the Golden State Freeway to the Santa Ana Freeway. The structure on which the participants are standing is a connection between the Santa Monica and Golden State Freeways; the structure is completed, but will not be in service until a portion of the Santa Monica Freeway across the Los Angeles River is open to traffic later this year.

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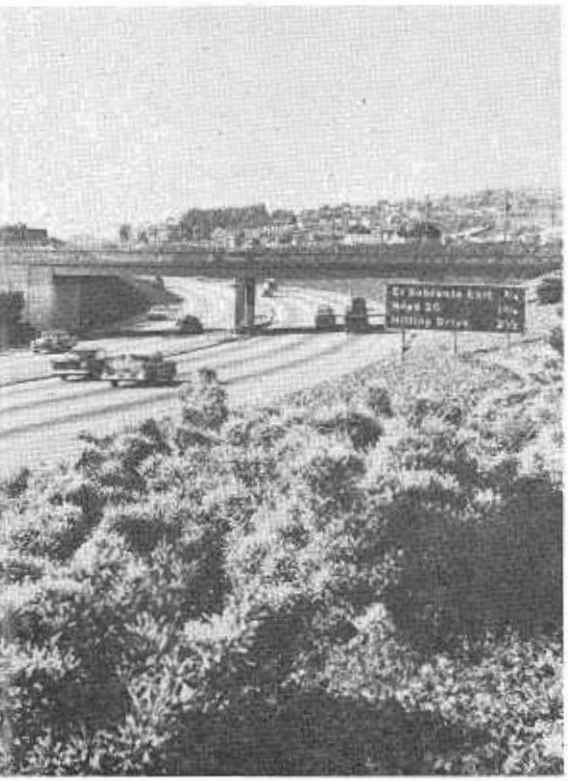
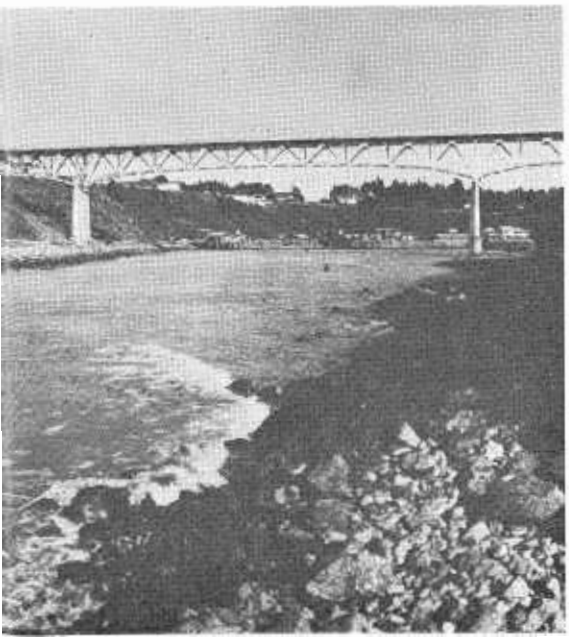


FRONT COVER—Looking north on U.S. 40 through Richmond at the Solano Avenue Overcrossing. Scotch broom, ground cover and other shrubbery plantings were completed in 1959 along the slopes of this section of depressed freeway. Photo by John F. Meyerpeter

BACK COVER—Many of the steel bridges on California's highways are being painted green to blend with natural colors of adjacent terrain and foliage. One of the first to receive this treatment is the Noyo River Bridge on Sign Route 1 in Mendocino County, shown here. Photo by John F. Meyerpeter



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Address communications to: EDITOR,

CALIFORNIA HIGHWAYS AND PUBLIC WORKS

P. O. Box 1499

SACRAMENTO, CALIFORNIA

Route Adoptions

Commission Approves Freeway Locations

IMPORTANT freeway routes in both northern and southern California were adopted by the California Highway Commission in February and March.

These included a route through Glendale and the Eagle Rock section of Los Angeles County; a route in Los Angeles, San Bernardino and Riverside Counties skirting the cities of Pomona, Chino and Ontario; a route in Santa Clara County involving the cities of Gilroy, Morgan Hill and San Jose, and a beltline route around and to the north of Sacramento.

The Glendale-Eagle Rock adoption involves 6.6 miles of freeway on Sign Route 134 and the action was taken following a public hearing by the Commission in Los Angeles. The Commission followed the recommendation of State Highway Engineer Womack for a route through Glendale, but adopted a route referred to as the "D" line through Eagle Rock, a route located a quarter to a half mile north of the route which Womack had recommended.

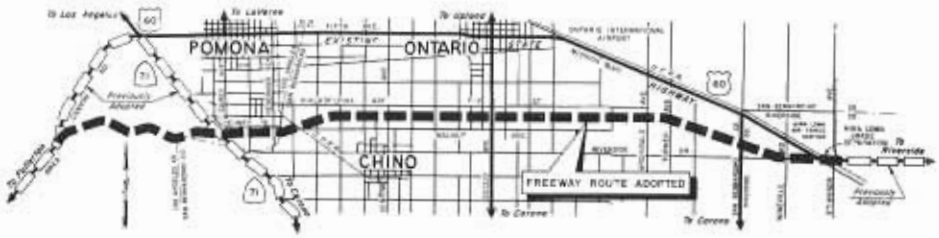
For the 13.9 miles of freeway in the area of Pomona, Chino and Ontario the Commission adopted the route recommended by Womack from Sign Route 71 at Garey Avenue to Mira Loma Grade Separation. The Commission urged Womack, in designing the freeway, to depress it under city streets and county roads in the Chino area. If this should involve serious engineering and financial problems, Womack is to refer the matter back to the Commission for further comment, but not in regard to location.

The adopted Santa Clara County route is for 24.6 miles of freeway for U.S. 101 between south of Gilroy and San Jose. The Commission's decision was based on freeway route studies dating back several years, a public hearing in San Jose in January, 1961, and the recommendation of Womack.

The Sacramento beltline route, adopted in March, will form a component part of a proposed freeway network in the metropolitan area of the Capital. It is designated as Interstate Route 880 and connects with U.S. 40 (Interstate 80) in Yolo County and north-east of Sacramento near Watt Avenue.

There were two other freeway route adoptions in March. One was for one of the last links in the complete routing of the Westside Freeway. The newly adopted route extends 32.2 miles from Benjamin Holt Drive at the north city limit of Stockton to 0.8 mile south of Freeport in Sacramento County.

The other adoption was a route for the relocation of 7.6 miles of U.S. 399 in Kern County between 2.25 miles northeast of Valley West Road and 0.2 mile east of State Highway Route 139 (Enos Lane).



Bay Area Freeways

By J. P. SINCLAIR, Assistant State Highway Engineer

"ROUTES, Roads and Rolling Wheels" is not the title of an "adult western," but a new 3-R twist to a chapter heading on highway transportation in the social studies text of California's fourth graders. In other elementary classrooms, students are discussing articles in the April 5, 1961, issue of "Junior Scholastic" magazine about the impact of change on our communities; the problems of population, housing, transportation, greenbelts, urban renewal and suburban development.

President Kennedy has stressed the need for all citizens, all levels of government and for all business and industry to plan for future growth on a coordinated basis. Recently, at M.I.T., scientists from 30 nations met to discuss similar problems on a global basis prompted by the effects of technology and population explosions in a shrinking world community.

These considerations are not removed from the subject at hand—the vital role of freeways today. Since freeways are planned to meet condi-

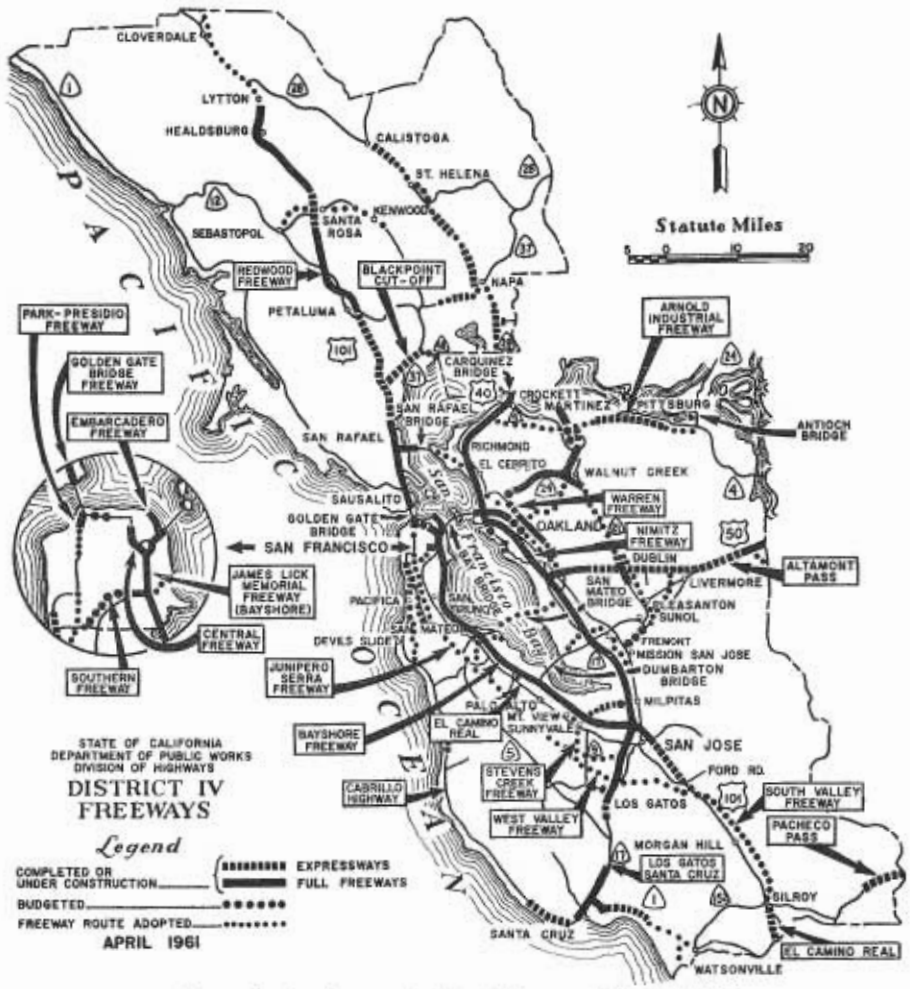
Portola School
April 3, 1961
Los Altos, Calif.

Dear Sirs:
I am making a report about Routes, Roads and Rolling Wheels. I would like to have pictures of road signs.

Thank you.
Curt Heskett

A letter typical of the many received from young school children requesting information on some phase of the highway program for projects they are doing in class, this one from Curt Heskett of Los Altos.

Looking north at construction operations at Greenbrae on U.S. 101. The new off-ramp bridge connection to San Quentin and the Richmond-San Rafael Bridge is located right foreground. The old bridge is being removed at the center.



A map showing the current status of freeways in the Bay Area.

tions 20 years hence, the best estimate of the future is basic to freeway planning. The young and the not-so-young must think in terms of the future; the young, because they will inherit our freeways and, hopefully, benefit from our experience; the not-so-young, because action is imperative. To procrastinate means chaos.

Freeway Impact

District IV is charged with planning, designing, constructing and maintaining San Francisco Bay Area freeways. The rapid development of our freeway system has raised immediate questions regarding community values and has focused attention on the considerable impact of freeways. This has dramatized the gap between freeway planning and other aspects of community planning. In turn, the various cities, counties and civic groups have responded by dusting off old, and implementing new comprehensive long-range plans to channel explosive growth into orderly patterns.

The policies and procedures established by the California Highway Commission for route selection and freeway design are directed at obtaining a maximum of community involvement. Studies are announced, alternative routes are presented, and detailed plans are reviewed through a continuing series of local public meetings and discussions with community planners.

It is during this three to five-year process that the freeway is integrated with all aspects of present and predicted area development. Route recommendations and design features are considered in light of the intangible and aesthetic, as well as the functional and economic factors which are brought out. The continuing re-examination of changing conditions as a basis for planning is essential. These plans become tomorrow's realities which in turn influence subsequent growth patterns.

The following review of construction progress and planning activities detail one facet of Bay Area growth.

U.S. 40—San Francisco to Carquinez Bridge

This important link of Interstate 80 was completed in August, 1960, when the portion of the Eastshore Freeway between El Cerrito Overhead and Jefferson Avenue in Richmond was opened to traffic. Completion of 12 major projects, including the new Carquinez Bridge and Crockett interchange, now provide a minimum six-lane, high speed bypass to replace the undivided highway formerly traversed by eastshore commuters between Oakland and Vallejo.

The last link between El Cerrito Overhead and Jefferson Avenue included construction of a direct connection to Hoffman Boulevard, State Sign Route 17, in Richmond and diamond interchanges at Central Avenue and Carlson Boulevard. A detailed account of this $5,313,000 project appeared in the July-August 1960 issue of this magazine.

During 1960, functional planting was added between Ridge Road in San Pablo and Crockett, and sign panels were installed between Richmond and Crockett. A blocked-out metal beam median barrier was installed between the Distribution Structure and El Cerrito Overhead.

A $39,000 contract was recently awarded for landscaping the Crockett interchange and Carquinez Bridges, and $280,000 has been budgeted for landscaping the freeway between El Cerrito Overhead and Jefferson Avenue.

The major U.S. 40 project presently under construction is the Bay Bridge reconstruction, being financed by toll bridge funds. This work includes rebuilding of the approach ramps and the Bay Bridge itself to carry five lanes of westbound traffic on the upper deck with eastbound traffic on the lower deck. This work is being administered by the Division of San Francisco Bay Toll Crossings. Also under construction is the widening on the south side of the Toll Plaza. This contract, also financed by toll bridge funds, will provide 17 lanes through

the Toll Plaza eastbound. As a part of this $515,000 project, the eastbound toll booths are being remodeled so that all collections will be made from the driver's side.

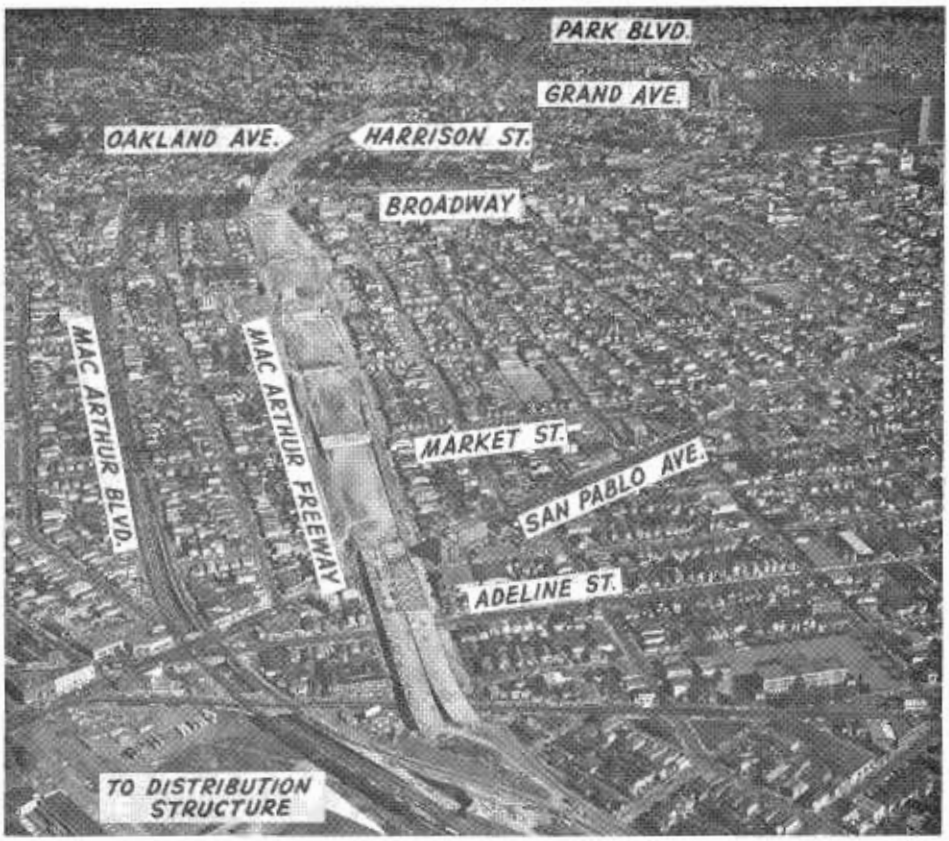
U.S. 50—MacArthur Freeway

Work is in progress on four of nine MacArthur Freeway projects and a fifth contract is expected to be advertised this summer. This section of U.S. 50 between the Distribution Structure in Oakland and Castro Valley is being constructed as an eight-lane interstate facility.

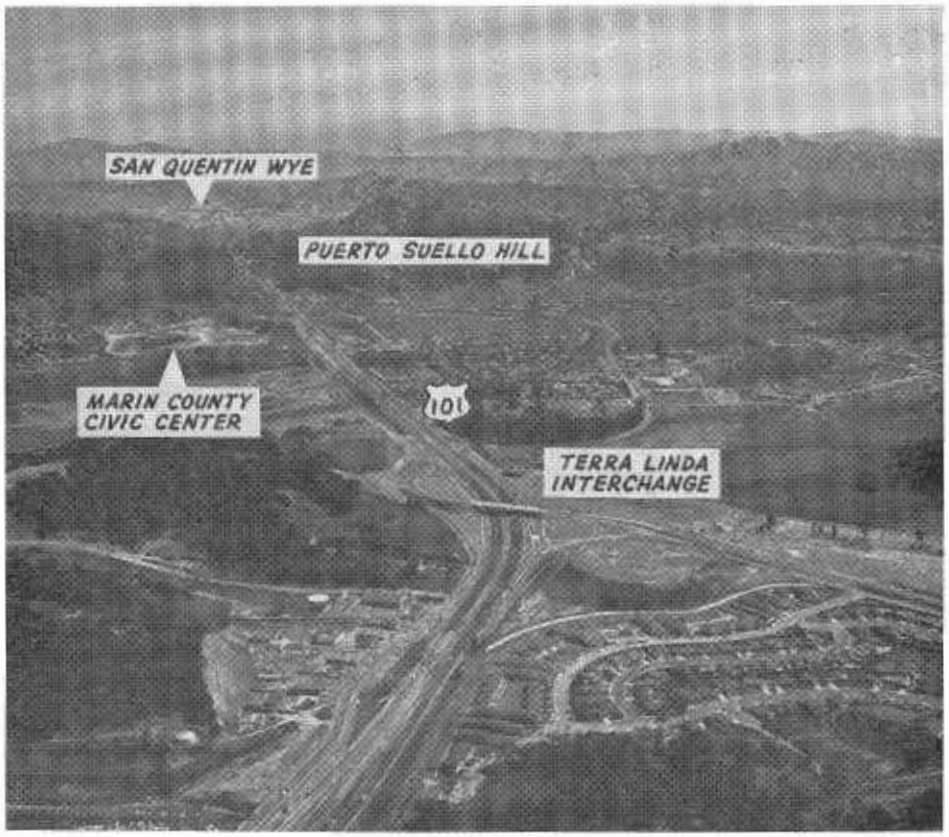
The first section that can be used by traffic consists of three projects, expected to be completed in February of 1962, between the Distribution Structure and Grand Avenue. Construction on the first unit between the Distribution Structure and Market Street was started in February of 1960. This project, estimated to cost $3,113,000, includes one interchange and two undercrossings. The Adeline Street Undercrossing is nearly 1,100 feet long and spans four streets. The work is being done by C. K. Moseman and Son.

The second unit let to contract is from Broadway to Grand Avenue. Guy F. Atkinson is the contractor on this $4,383,000 project, which includes a modified diamond interchange with additional connections in the vicinity of Oakland Avenue and Harrison Street. Structures are provided for the Broadway-Richmond Boulevard, Oakland Avenue and Chetwood Street Undercrossings. Embankment is being placed on the adjoining unit of construction between San Pablo Avenue and Webster Street.

The third unit will close the gap between the projects mentioned above. Peter Kiewit Sons Company started this $4,045,000 project in August, 1960. The future directional interchange between MacArthur and Grove-Shafter freeways is included. At this time, only the substructures of the interchange spans will be constructed since the Bay Area Rapid Transit District has indicated a desire to occupy the median of the Grove-Shafter freeway and the matter is currently under discussion. However, nine additional structures are being



The MacArthur Freeway under construction, looking east from above the San Pablo Avenue Underpass.



U.S. 101 in Marin County looking south toward San Rafael.

provided for separation of city streets and ramps.

The fourth contract will extend the freeway from Grand Avenue to Park Boulevard in Oakland, a distance of 1.7 miles. Two interchanges, a modified split diamond in the vicinity of Grand Avenue and Lakeshore, and a half diamond at Park Boulevard, are included in this $5,000,000 contract. Peter Kiewit Sons Company was awarded this contract in March, 1961. Separation structures are provided at Lakeshore Park, Lake Park, MacArthur Boulevard and Park Boulevard. Pedestrian overcrossings are being built at Van Buren and Santa Clara and a stairway is provided in the vicinity of Lagunitas Avenue. Eleven major retaining walls are included in the contract to reduce right of way requirements.

The fifth unit is three miles in length between Park Boulevard and Buell Street in the vicinity of Mills College. The project will include six half diamond interchanges, 15 traffic structures and a pedestrian overcrossing. Again, in order to reduce right of way requirements, 19 major retaining walls are being constructed on this $8,700,000 project.

Eight million dollars for a 3.5-mile portion between Kuhnle Avenue and the east city limits of Oakland near Durant Avenue has been included in the budget for 1961-62 and is expected to be advertised in December. The 0.8-mile gap between Buell and Kuhnle Streets and the two units from Durant Avenue to 173rd Avenue in Castro Valley, a distance of 5.2 miles, are in an advanced design stage and rights of way are being acquired and cleared.

Approximately $50,000,000 has been expended or budgeted to date for this 15.3-mile freeway. The March-April 1960 issue of this magazine contained a detailed background article.

U.S. 50—Castro Valley to San Joaquin County Line

A continuous freeway has been in traffic service between Oakland and Dublin since 1957 via portions of the Nimitz Freeway (State Sign Route 17), Route 228 easterly to Castro Valley, and U.S. 50. East of Dublin, the traveled way is presently constructed to expressway standards with controlled access but with intersections at grade.

Construction activities within this area have been relatively slight, limited to minor grading and resurfacing, and a landscaping project between Center Street in Castro Valley and the Nimitz Freeway. The latter project was completed in February of 1960 at a cost of $83,400.

Design studies are in progress for freeway widening to eight lanes for a 6.8 mile portion between Crow Canyon Road and west of Dublin. Studies are more advanced for the development of the existing expressway to initial six-lane, ultimate eight-lane freeway between Dublin and Greenville.

U.S. 101—Golden Gate Bridge to San Rafael

Construction is expected to be completed in August, 1961, on the third and final stage of the Greenbrae Interchange. This $1,152,000 project being constructed by Peter Kiewit Sons Company, will create a three level separation structure which will provide a bridge ramp connection to Sir Francis Drake Boulevard for northbound freeway traffic. Also included in the contract is the removal of the old lift span bridge across Corte Madera Creek.

Completion of this project will provide a six-lane freeway north from the Golden Gate to San Rafael. However, planning studies are in progress to provide additional lanes on uphill grades between the Golden Gate Bridge and Richardson's Bay. Hearings have been completed concerning future expansion to eight-lanes between San Quentin Wye and Puerto Suello Hill in San Rafael. Design studies are underway.

A $61,700 landscaping project, including the planting of numerous redwood trees between Corte Madera Creek and Richardson Bay Bridge was completed in December, 1960. Similar landscaping is expected to commence in the near future between Waldo Undercrossing and Freitas Parkway if the necessary billboard ordinances are enacted by cities of Larkspur and San Rafael.

Several other projects have been budgeted and should be under construction in the near future. Two hundred thousand dollars is set aside for grading, paving and landscaping the Vista Point north of the Golden Gate Bridge. One hundred seventy-five thousand dollars is budgeted for widening the Marin approach to the bridge and the work is being coordinated to meet the Golden Gate Bridge and Highway District's plans for widening the northerly approach spans of the bridge.

U.S. 101—San Rafael to Petaluma

The first of many projects to convert this section of U.S. 101 from an expressway to a six-lane freeway was completed in January, 1961, between Lucas Valley Road and San Pedro Road. The work was done by Fredrickson and Watson Construction Company. Included in this $1,076,000 project was the trumpet-type Terra Linda Interchange at Manuel Freitas Parkway, frontage roads and a partial interchange at San Pedro Road in the vicinity of the new Marin County Civic Center.

Construction is expected to be completed in September, 1961, on the contract being performed by Charles L. Harney, Inc. at Miller Creek Road. The diagonal ramps and the freeway overcrossing of a future four-quadrant cloverleaf interchange serving the Marinwood development and St. Vincent's School are being built at this time. A northbound climbing lane over St. Vincent's Hill, is also included in the work, estimated to cost $633,000. The same contractor is reconstructing and extending a culvert at Gallinas Creek at the north city limits of San Rafael. This $125,000 project will improve drainage conditions and will minimize traffic problems during the construction of the future eight-lane freeway in this area.

Contracts for an initial six-lane, future eight-lane freeway from Miller Creek to north of Entrada Drive at Rafael Village just north of Ignacio and for an interchange at Ignacio Wye are expected to be ready for advertising early in 1962.

Studies are under way for an eight-lane freeway between Lincoln Avenue in San Rafael and Miller Creek for conversion of the existing expressway between Atherton Avenue in Novato and 0.3 mile south of Petaluma to freeway standards. Traffic origin and

destination surveys are now being evaluated for the unit between the Ignacio Wye interchange and Atherton Avenue in Novato.

About 1,000 trees, mostly redwoods, are being planted as part of a $62,000 landscaping project on the completed freeway in the vicinity of Washington Avenue in Petaluma.

U.S. 101—Petaluma to Mendocino County Line

By 1957, an 18.5 mile section of freeway was completed from south of Petaluma to the southerly city limits of Santa Rosa. Within the City of Santa Rosa the existing expressway has been in use for many years. Studies for the conversion of this facility to an initial four-lane, future six-lane full freeway are well along and rights of way are now being appraised and acquired.

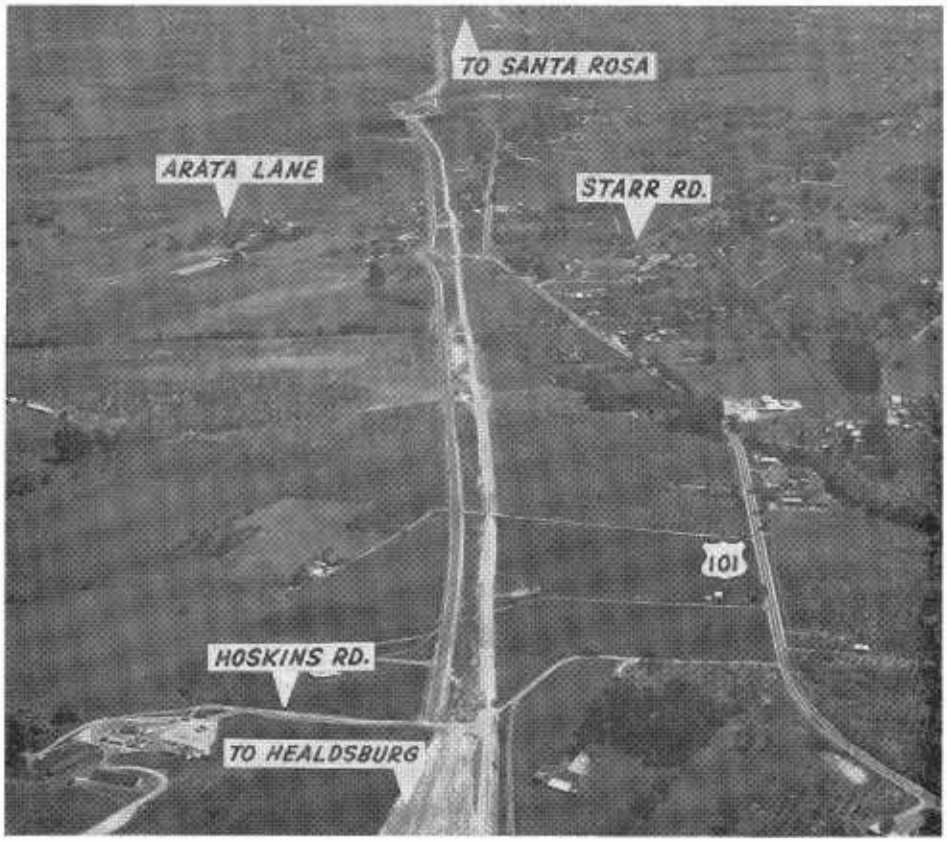
Appraised 16 miles of freeway from the north city limits of Santa Rosa to Lytton will be in use with the completion of two contracts next year. Guy F. Atkinson Company is the contractor on a $4,386,000 project between Mendocino Avenue in Santa Rosa and Grant Creek. Five interchanges will be constructed between Santa Rosa and Windsor, and grading will be done between Windsor and Grant Creek. The second contract includes paving the graded portion between Windsor and Grant Creek and the construction of frontage roads and interchanges at Windsor and Grant Street. Ball and Simpson is the contractor on this $3,110,000 project.

North of the present construction, the Healdsburg Bypass has been completed to Lytton. Guy F. Atkinson Company was the contractor on this $2,354,000 unit which was opened to traffic last December.

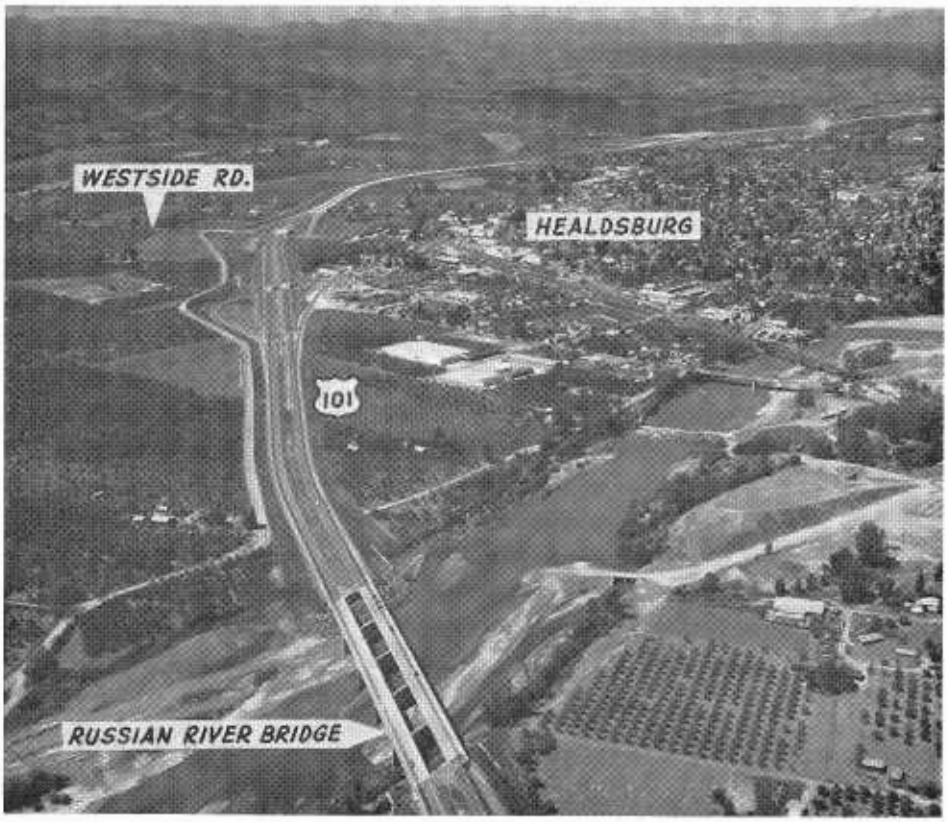
The route north of Lytton to the county line has been adopted. An initial four-lane, ultimate six-lane freeway is being planned for this 18½ miles.

U.S. 101 (Bypass)—San Francisco to Palo Alto (Bayshore Freeway)

Although 26 miles of continuous six-lane freeway has been in use between San Francisco and Palo Alto for several years, the congestion resulting from heavy peak hour traffic dictates further improvements. The



U.S. 101 south of the Healdsburg Bypass, looking southward, showing construction now under way.



The Healdsburg Bypass with the new twin bridges across the Russian River (foreground).

first of these, a widening project in the vicinity of San Franicsco International Airport, was completed in April, 1961.

A fourth lane in each direction was added between Broadway in Burlingame and San Bruno Avenue in San Bruno. The added northbound lane begins at Peninsular Avenue. At the Millbrae Avenue interchange, a direct right-turn connection to the southbound freeway was added and remaining ramp outlets were improved. L. C. Smith Company was the contractor for this $1,662,000 project which included installation of a double blocked-out metal beam barrier between opposing traffic lanes through interchange areas.

The widening has provided considerable traffic relief in the vicinity of San Francisco International Airport and a reduction in travel time between Peninsula communities and San Francisco.

Also under way is a landscaping project between 16th Avenue in San Mateo and San Carlos. Approximately $71,300 is being expended to provide trees, shrubs and ground cover on the approaches to structures. A similar project was completed in July of last year between Harbor Boulevard in Redwood City and University Avenue in Menlo Park. Cost of this planting was approximately $194,000. Another $150,000 has been budgeted for landscaping the section between Spruce Avenue in Redwood City and University Avenue.

A $41,000 contract for the installation of cable-chain link median barrier was completed in December between Third Street in San Francisco and Sierra Point Overhead. Further extension of the barrier now being planned will provide 17 miles of cable-chain-link median barrier from Sierra Point to the Redwood Creek Bridge in Redwood City.

U.S. 101 (Bypass)—Palo Alto to San Jose (Bayshore Freeway)

Two contracts in Santa Clara County are expected to be completed in December, 1961, climaxing several years of intensive construction effort to provide a continuous freeway from San Jose to San Francisco.

The Bayshore Freeway (looking south) near the International Airport where a fourth lane in each direction has recently been completed.

The six-lane facility was extended southerly from the San Mateo County Line to Stierlin Road in Mountain View in May of last year. Interchanges were provided at Embarcadero, San Antonio and Middlefield Roads on this 4.4 mile, $3,391,000 project constructed by L. C. Smith and Concar Ranch and Enterprises.

During 1958 and 1959, interchanges were completed at Moffett Boulevard and at the intersection of U.S. 101 (Bypass) and State Sign Route 9 (Mountain View-Alviso Road). A contract connecting these interchanges and extending the freeway southerly to Fair Oaks Avenue is currently in progress. Interchanges are being constructed at Reingstorff Avenue, Stierlin Road, Ellis Street, Mathilda and North Mathilda Avenues. The work, being performed by L. C. Smith and Concar Ranch and Enterprises, includes construction of a freeway section on State Sign Route 9 from Bayshore Freeway to 0.2 mile east of Borregas Avenue.

Other features of this $4,518,000 contract are the improvement of existing channel facilities of the Santa Clara County Flood Control District and realignment and channel widening on Guadalupe River at the southerly end of the project. The cooperative project for the channel improvements provided a source of material for the freeway with channel right of way being furnished by the Flood Control District.

Allen M. Campbell Co. is constructing the last section of Bayshore Freeway in this area. This 6.1 mile contract provides a four-lane freeway between Brokaw Road and the future Guadalupe Parkway and six lanes from there to Morse Avenue where it joins the section mentioned above. This work, costing approximately $5,670,000, provides cloverleaf interchanges at Fair Oaks Boulevard, Lawrence Station Road, San Tomas Aquinas Boulevard and De La Cruz Boulevard.

Southerly of this portion, a contract was completed last May between Brokaw Road and Taylor Street in San Jose. Included in this $4,317,000 project was the extension of State Sign Route 17 as a freeway to First Street

in San Jose. Thirteen structures were built including those within the cloverleaf interchange at the intersections of Nimitz, Sign Route 17 and Bayshore Freeways. Interchanges were also provided at North First Street, existing Sign Route 17 and old Bayshore highway. These projects were discussed in detail in an article on San Jose Freeways in the July-August 1960 issue of this magazine.

Approximately 5,000 shrubs, 400 trees and ground cover were planted by Rudolph Watson between Coyote Creek and Santa Clara Street in San Jose at a cost of $65,000. Funds in the amount of $300,000 have been budgeted for extending landscaping north on Bayshore to Brokaw Road and for planting on Nimitz and Sign Route 17 Freeways between Bascom Avenue and old Bayshore Highway.

U.S. 101 (Bypass)—San Jose to U.S. 101 at Ford Road (Bayshore Freeway)

An expressway has been in operation within these limits since 1947. Design studies are now under way for conversion to an ultimate eight-lane freeway. Public meetings have been held and a freeway agreement has been executed with the City of San Jose for that portion of the highway within the city limits. Agreements with the county covering other portions are pending.

Funds in the amount of $850,000 are budgeted for grading, paving and structures at Tully Road. This project will provide a full four quadrant cloverleaf interchange with collector roads and is expected to be advertised this summer. Another project will add facilities for turning movements at the McKee Road interchange constructed in 1957.

U.S. 101 in San Francisco

Within San Francisco, U.S. 101 traverses city streets, the Central Freeway and portions of the James Lick Memorial and Southern Freeways. Construction and design activities, except for landscaping and minor projects, are confined at present to the Southern Freeway. Planning studies are currently under way by the City for reappraisal of the ultimate freeway system in San Francisco.

An aerial view of a capacity crowd at the San Francisco Giants' Candlestick Park, with the over-water section of the Bayshore Freeway curving south around Sierra Point toward South San Francisco and the Peninsula communities.

Work is in progress on repairing the expansion joint metal plates on the Marina Viaduct approaches to the Golden Gate Bridge. This $160,000 contract is being performed by the Independent Iron Works. Bids were opened April 26 for resurfacing Van Ness Avenue (U.S. 101) between Lombard Street and Golden Gate Avenue estimated to cost approximately $150,000.

Central Freeway

Two units of the Central Freeway have been open to traffic between James Lick Freeway and the vicinity of the Civic Center since April, 1959.

This past year, approximately 750 eucalyptus trees, 3,000 shrubs and 38,000 ivy plants were set out between Valencia and Turk Streets by A. S. Brown Landscaping Co. under a $72,300 contract.

James Lick Memorial Freeway

Work on this six and eight-lane freeway in the past few years has consisted of landscaping, erosion control, installation of median barriers and the construction of direct interchange connections to the Southern Freeway at Alemany Boulevard. Although part of U.S. 101 from the Division Street Distribution facilities to the Southern Freeway, James Lick Memorial Freeway extends from the San Francisco-Oakland Bay Bridge to the San Mateo County Line and is used by 150,000 vehicles a day.

Minor projects completed during the past year included resurfacing and reconstruction of curbs and gutters in the vicinity of Alemany Rotary interchange at a cost of approximately $20,600. A blocked-out metal beam median barrier was installed between Army Street and Third Street in two contracts at a total cost of approximately $100,000. An $11,700 landscaping project between the 18th Street and 22nd Street pedestrian overcrossings was also completed.

A project will soon be advertised for functional planting along a 1.35 mile section of James Lick Freeway between Paul Avenue Undercrossing and Powhatan Avenue just north of

Looking south along the Bayshore Freeway through San Jose.

Looking south toward San Jose from above the Bayshore Freeway under construction.

Bayshore Freeway construction in the Mountain View area with Moffett Field indicated (left foreground).

the Southern Freeway Interchange, for an estimated cost of $89,500.

Southern Freeway

The Southern Freeway extends westerly from the James Lick Memorial Freeway to a proposed connection with the future Junipero Serra Freeway in Daly City and forms a part of U.S. 101 to San Jose Avenue. The first unit was opened to traffic in July, 1960, when Guy F. Atkinson Co. completed a $7,565,000 interchange project at James Lick Freeway. Direct connections are provided for all turning movements and provision has been made for future freeway extension east and northerly to the Embarcadero Freeway. This contract, financed partly with $1,450,000 of city funds, included reconstruction of Bayshore Boulevard. The Highway Commission has under consideration a proposed routing for a future connection with the Embarcadero Freeway.

The second unit between Milton Street and the completed interchange, is being constructed by Charles L. Harney, Inc., with $4,273,000 allotted for providing 1.1 miles of six-lane, future eight-lane, freeway and structures to carry Alemany Boulevard traffic over the freeway in the vicinity of Gaven and Condon Streets. Mission Street and Justin Drive traffic will also be carried over the freeway. A temporary structure has been built to detour Mission Street traffic during construction and the city is participating in the cost of relocating a major sewer within the limits of the contract.

Funds have been budgeted for two additional units of the Southern Freeway and design studies are under way. A one and three-tenths mile, $6,000,000, project between Ocean Avenue and Mission Street will be advertised this summer. It is expected that the 1.8 mile section between Orizaba Avenue and Ocean Avenue, estimated to cost $4,600,000, will be ready for contract early next year.

Funds have been budgeted for a $188,300 landscaping project between Boylston Street and the James Lick Freeway and studies are in progress for additional landscaping.

U.S. 101—El Camino Real—San Francisco to Ford Road

Minor traffic signal, channelization, resurfacing and widening projects were completed during the past year at numerous locations along this arterial which links Peninsula communities. Approximately $191,000 was expended on eight projects which were financed in cooperation with the cities concerned.

A 1.2 mile contract in Daly City was typical. Approximately $94,500 was expended to remove the old street car tracks on Mission Street, construct a median island and install traffic signals. Daly City contributed approximately $7,400 and the City of San Francisco $12,600 for this work.

Portions of El Camino Real have previously been widened to six lanes with a median separation and funds have been budgeted for two additional projects. The City of Millbrae is contributing $140,000 as its share of a $385,000 project between Taylor Boulevard in Millbrae and Santa Helena Avenue in San Bruno. A 2.7 mile portion between Matadero Creek and University Avenue in Palo Alto will be widened to six lanes by a $1,330,000 project to which the City will contribute $440,000. Both of these projects will be advertised in the near future.

Design studies are under way for widening the portion northerly from Millwood Drive in San Bruno to Old Mission Road in Colma.

Public meetings have been held and plans established for widening 13.7 miles between Matadero Creek in Palo Alto and State Sign Route 17 in San Jose. Aerial photographs have been received for planning studies for an interchange at Page Mill Road in Palo Alto. Interchange studies have also been made at San Antonio Road in Mountain View. Construction of interchanges at the major crossings of U.S. 101 is contingent on substantial participation by local agencies.

Plans are being prepared for widening of the remaining three-lane section between Tully Road and Ford Road to a four-lane divided arterial. This five miles is the last remaining section of three-lane highway on U.S. 101 between San Francisco and Gilroy.

U.S. 101—El Camino Real—Ford Road to San Benito County Line

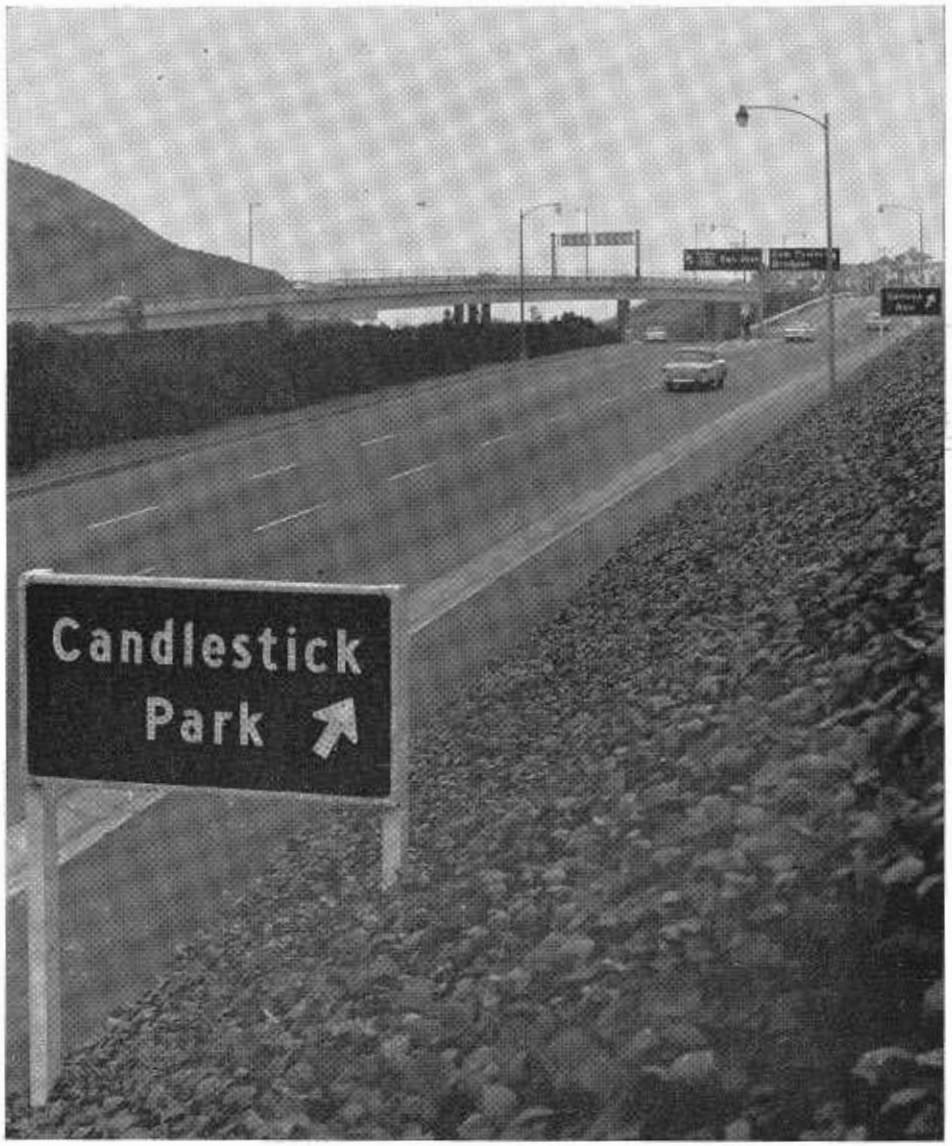
The route was adopted after Commission Hearing in February 1961, for an ultimate eight-lane freeway between Ford Road at the junction of Bayshore and El Camino Real and Thomas Road south of Gilroy. This proposed 25-mile facility will be located east of existing U.S. 101.

Minor interim projects are being constructed within these limits. During the past year, $25,000 was expended to provide left turn lanes at Church Street and Burnett Avenue in Morgan Hill. Funds in the amount of $220,000 have been budgeted for resurfacing and reconstructing an eight-mile section from Madrone Underpass in Morgan Hill to Coyote.

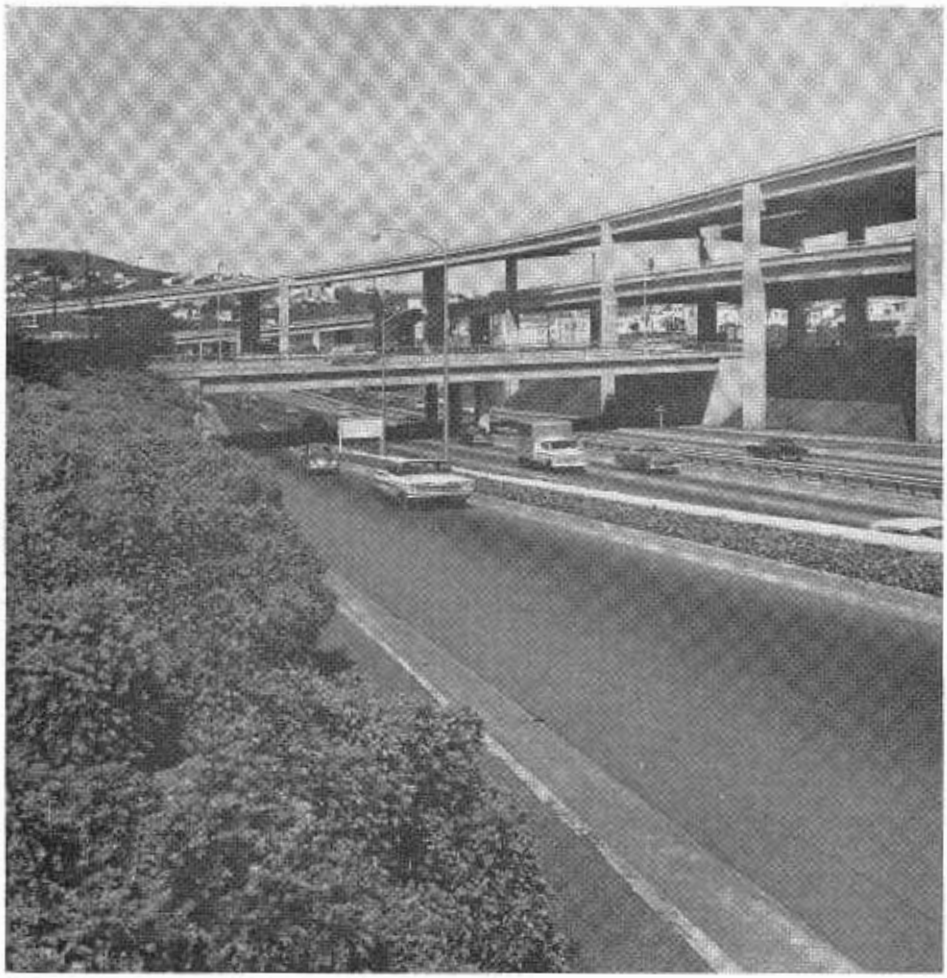
Since 1951, a four-lane divided expressway has been in operation south of Gilroy to the Pajaro River at the San Benito County line.

Embarcadero Freeway

The double-deck Embarcadero viaduct has been in service for two years from the Bay Bridge approaches around San Francisco's financial district to Broadway. Design studies are under way for access ramps to Clay and Washington Streets at an estimated cost of $1,470,000. Construction is to be correlated with widening of the city streets in order to properly



A frontage road beside the James Lick (Bayshore) Freeway in San Francisco showing ivy ground cover on slopes and shrubbery planting (left) to screen freeway lanes.



The Silver Avenue offramp beside the James Lick (Bayshore) Freeway in San Francisco, looking northeast at the three-level interchange for the Southern Freeway crossing. The interchange area has been landscaped with Scotch broom and ivy ground cover. Blocked out metal beam guard rail divides opposing traffic lanes on the freeway.

handle the ramp traffic as a part of the Golden Gateway Redevelopment project now in progress.

The California Highway Commission has under consideration the routing recommended by the San Francisco Board of Supervisors for the southerly extension of the Embarcadero Freeway between Howard Street and the Southern Freeway extension at Evans Avenue. Planning studies are also in progress for the Hunters Point Freeway extending from Evans Avenue to the Bayshore Freeway near the south city limits. The Southern and Embarcadero Freeway extensions are included in State Highway Route 253 added to the system by the 1959 session of the Legislature.

During the past year, parking lots and landscaping have been added under the viaduct. Another project, which received considerable attention was the $25,400 viewing area completed in January on the upper deck of the Embarcadero Freeway which provides pedestrian strolling areas and parking for 60 vehicles.

Funds have been budgeted for extending of the Southern Freeway easterly from James Lick Memorial Freeway to meet the proposed Embarcadero Freeway near Oakdale Avenue. This 0.7 mile section is estimated to cost approximately $5,500,000 and the City of San Francisco is acquiring the rights of way for the project in accordance with state law.

Junipero Serra Freeway (Interstate 280)

Detailed design studies are being made and rights-of-way are being acquired on this Interstate route down the Peninsula from San Francisco to connect with Sign Route 17 at Moorpark Avenue in San Jose. Fourteen projects are planned to complete this 47 miles of freeway. Interstate 280 follows Sign Route 17 to join Interstate 680 (Nimitz Freeway) at Bayshore in San Jose.

Eight lanes will be constructed between Alemany Boulevard in San Francisco and Eastmoor Avenue in Daly City. From Eastmoor Avenue to Woodside Road near Atherton, eight lanes will be built. Six lanes will be constructed initially on the remaining portion between Woodside Road and Sign Route 17.

Cabrillo Highway (Sign Route 1)— Watsonville to San Francisco

Planning studies have been completed for 5.2 miles of initial four-lane, ultimate six-lane freeway between Watsonville and Rob Roy Junction south of Aptos. Public hearings on this project are scheduled for this summer.

A $612,000 contract at Capitola is under way by L. C. Smith on the first of a series of projects to convert the existing expressway between Rob Roy Junction and Santa Cruz to full freeway. It includes construction of the 41st Avenue Interchange and a frontage road between South Rodeo Gulch and 17th Avenue.

North of Santa Cruz, construction of two lanes of a future four-lane expressway has been in progress for several years. Two such projects were completed during the past year, jointly financed by the State and the three counties of Santa Cruz, San Mateo and San Francisco under Joint Highway District No. 9. $844,000 was expended for 1.5 miles of two-lane roadway and 1.7 miles of four-lane expressway from Wilder Creek to 4.0 miles south of Davenport. Four-lane expressway was provided for passing in areas where the terrain creates sight distance problems.

A similar $393,000 project was constructed between New Years Creek near the Santa Cruz County line and Whitehouse Creek. These projects complete the work of Joint Highway District No. 9 which was established in 1928 for the purpose of building State Sign Route 1 between Santa Cruz and San Francisco.

Funds in the amount of $550,000 have been budgeted for an initial two-lane replacement of the Tunitas Creek Bridge and approaches. Design is complete and rights-of-way are being purchased for a future six-lane expansion.

Two hundred ten thousand dollars is budgeted for resurfacing portions of the 37 miles between Davenport and Princeton, south of Half Moon Bay.

Design studies are under way to provide a four-lane, ultimate six-lane facility from Half Moon Bay Airport to Skyline Boulevard in Daly City and thence to a junction with Junipero Serra Freeway. Included in this section is the conversion of the existing four-lane expressway between Manor Drive in Pacifica and Skyline Boulevard to a six-lane freeway and a relocation around the Devil's Slide area between Montara and Pacificia for which the freeway routing was established last December.

State Sign Route 1—North of San Francisco

Planning studies for relocation of Sign Route 1 between Manzanita at Richardson Bay, four miles north of Golden Gate Bridge, and Olema, were presented at public meetings. Further consideration of the route has been postponed pending legislative determinations regarding scenic highways.

Work performed during the past several years has consisted of reconstructing roadways and improving drainage facilities. Two such projects were completed in the last year. Nearly $100,000 was expended between Muir Beach and 5.3 miles south of Olema and $172,000 was spent to reconstruct and resurface portions of the existing two-lane highway between the Marin County Line and Bodega Bay. Construction has started on a $150,000 contract for grading and paving a 0.5 mile section north of Jenner. A 1.6 mile project to perform similar work north of Fort Ross has been planned.

Bay Front Freeway

Designated by the 1959 Legislature as State Highway Route 289, this route will be located east of the Bayshore Freeway, extending from San Jose to a connection with the future Hunters Point Freeway in San Francisco.

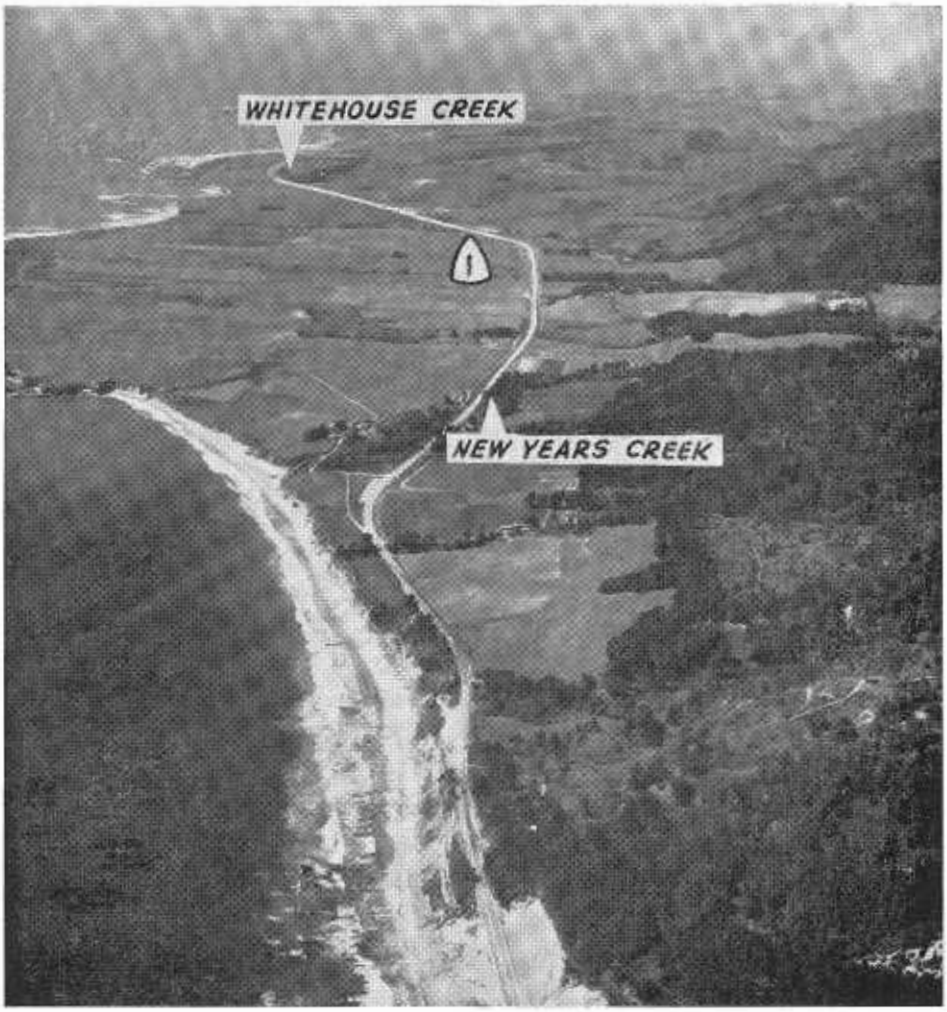
Approximately one and one half miles of the route across Brewer's Island at the westerly end of the San Mateo-Hayward Bridge has been adopted and geometric studies for the future interchange at the intersection with State Route 105 are under way. This section was established in order to enable planning to proceed in connection with development of Brewer's Island as a planned community.

Stevens Creek Freeway

Design studies are in progress for the new Stevens Creek Freeway between the Junipero Serra Freeway and Bayshore Freeway near Mountain View. The first unit will be a four-lane section 3.1 miles in length between the Junipero Serra Freeway south of Homestead Road in Cupertino and El Camino Real in Sunnyvale. The remaining 2.4 mile portion between El Camino Real and Bayshore Freeway is being designed on an initial four-lane, ultimate six-lane basis.

An interim four lane arterial project on State Sign Route 9 along the present Mathilda Avenue routing was completed in November from the Southern Pacific Railroad east of El Camino Real to an interchange at Bayshore Freeway in Sunnyvale. The cost of constructing two additional lanes and installing signals and lighting was $195,000. This section, for which the city purchased rights-of-way, will be relinquished to the city when the Stevens Creek freeway is completed.

The California Highway Commission has authorized development of the existing State Sign Route 9 to a four lane arterial between Azule north of



Construction on State Sign Route 1 between White House and New Year's Creek in San Mateo County.

Saratoga and El Camino Real in Sunnyvale. The County of Santa Clara will purchase the rights-of-way for this cooperative interim project.

Skyline Boulevard

State Sign Route 5 is a scenic, conventional two-lane highway following the crest of the coastal range between San Francisco and Sign Route 17 south of Los Gatos.

North from Ralston Avenue to Crystal Springs Road in San Bruno, the route will be developed as a part of the Junipero Serra Freeway. Design studies are under way for a $4,950,000 four-lane, future six-lane freeway between Crystal Springs Road and Cabrillo Highway (Sign Route 1) in Daly City. An expressway has been in service from Cabrillo Highway to Sloat Boulevard in San Francisco since 1956.

Sign Route 17—Santa Cruz to San Jose

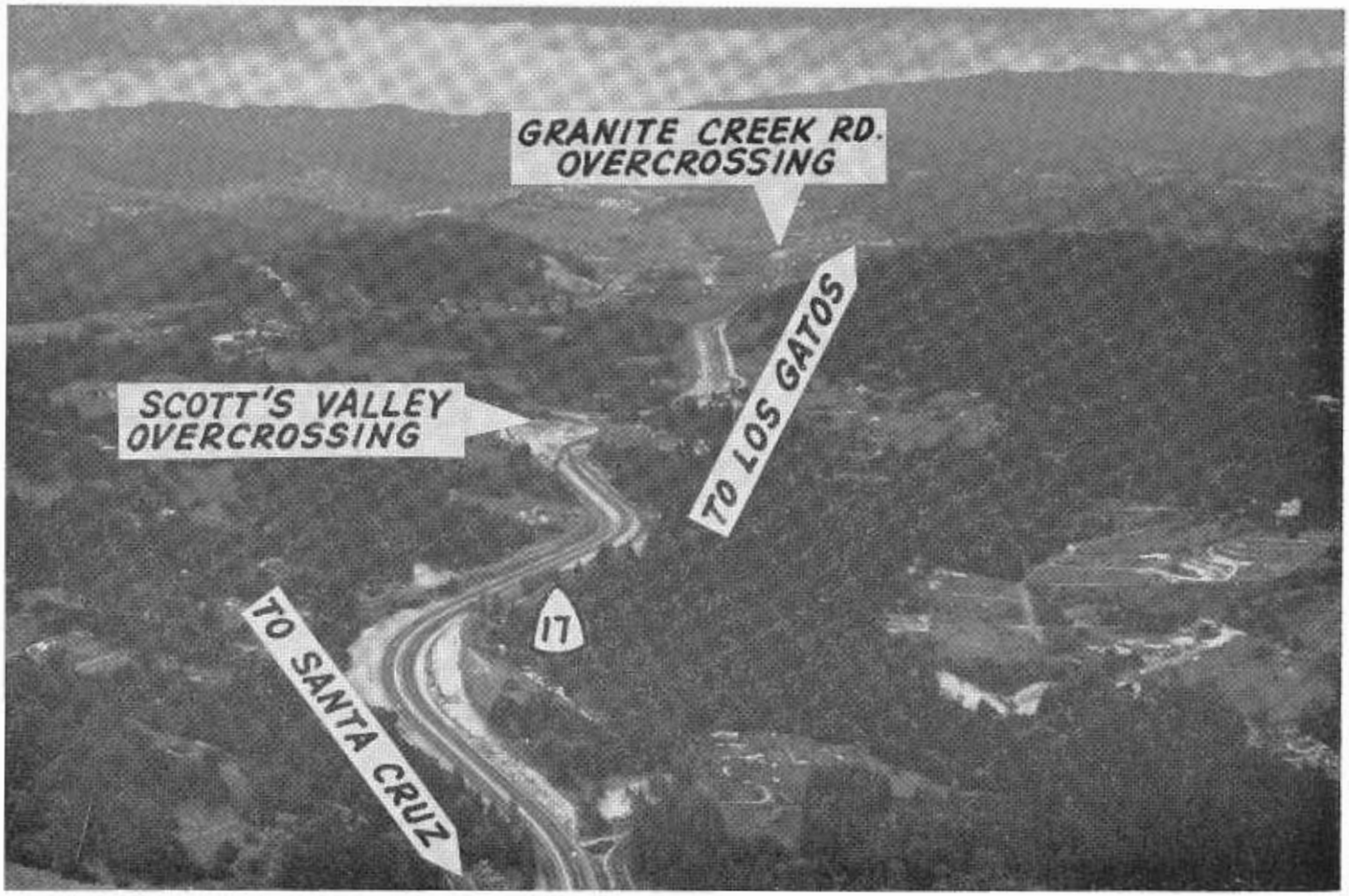
Three major construction projects and several landscaping contracts were completed during the past year on this route linking the Bay Area communities with the recreation areas in and near Santa Cruz. Immediately north of Santa Cruz, a 3.3 mile section of four-lane expressway to Carbonera Creek near Glen Canyon Road was constructed by Frederickson and Watson Construction Co. Interchange facilities were constructed at Pasatiempo and frontage roads were provided on this $1,650,000 contract.

From Glen Canyon Road, the expressway is being extended northward three miles on new alignment at a cost of $1,288,000. This contract includes interchanges at Granite Creek and Glen Canyon and an overcrossing at Scott's Valley. The existing three-lane highway through Scott's Valley will continue to serve local traffic.

A two and one-half mile section of four-lane freeway was constructed between Bascom Avenue and North Fourth Street in San Jose at a cost of $3,212,000. This contract, together with a portion of SSR17 and interchanges constructed as a part of the Bayshore Freeway project through San Jose, completed the freeway from Los Gatos to Oakland in June, 1960. These and related projects in the San Jose area were described in detail in the July-August 1960 issue of *California Highways and Public Works.*

Landscaping between Roberts Road in Los Gatos and Bascom Avenue in San Jose was completed at a cost of $79,000. Approximately 2,300 redwoods, 1,000 shrubs and over 100,000 ivy plants were planted by Shawn Co. Another landscaping project, at Saratoga Avenue Interchange in Los Gatos, included redwood trees and approximately 8,000 shrubs planted by Rudolph Watson at a cost of $19,000.

Other completed contracts included paving portions of old Sign Route 17 between Bascom Avenue and Bayshore Freeway and a $226,000 reconstruction and resurfacing project between the Santa Cruz-Santa Clara



Looking north along State Sign Route 17 near Santa Cruz.

County line and 0.7 mile south of Black Road. Traffic signs, highway lighting and ramp widening and channelization are being constructed at the intersection of the freeway off-ramp with Camden Avenue in Campbell. The City of Campbell is contributing $11,700 to this $56,700 project.

Two hundred thousand dollars has been budgeted for another landscaping project between Bascom Avenue and Bayshore Freeway.

Nimitz Freeway (Sign Route 17)—San Jose to Oakland

Although a continuous freeway has been in service since 1958, additional lanes, interchange and separation facilities, and median barriers are being added.

Funds in the amount of $4,800,000 have been budgeted for adding two lanes to the existing six-lane section between Hegenberger Road and Fallon Street in Oakland. Median barriers, ramp revisions and the widening of overhead structures are included in this project, and the present left hand take-off at 42nd Avenue will be replaced by a right hand take-off.

Design is under way for extending the eight-laning from Hegenberger Road to the junction with Route 228 in San Leandro and for widening to six lanes from Route 228 to Jackson Street in Hayward. Studies are also in progress for converting separations to interchanges at Hacienda Avenue in Hayward and Stevenson Boulevard in Fremont and for expansion of the existing First Avenue Interchange to a full cloverleaf.

The City of San Leandro contributed $138,000 for the purchase of rights-of-way and for construction of approaches to the Floresta Boulevard Overcrossing which was completed in March of this year. Total project cost was $276,000. A cable-chain link barrier was constructed between Washington Avenue in San Leandro and 98th Avenue in Oakland, and blocked-out metal beam guard rail was constructed between 98th Avenue and High Street on a $206,000 contract. Blocked-out metal beam barrier was also installed between Fallon Street and the Cypress Street Viaduct in Oakland as a part of a $290,000 project which also included a similar installation on U.S. 40 north from the Distribution Structure to the El Cerrito Overhead.

Other projects completed were the planting of eucalyptus trees and shrubs on a $53,800 landscaping project between Linden Street and Fifth Avenue Overhead in Oakland and the placing of sidewalk railing fences on the First Avenue, Washington Avenue and Hacienda Avenue Overcrossings.

An additional $120,000 has been budgeted for landscaping 2.3 miles between Central Avenue and Thornton Avenue in Fremont.

Sign Route 17—U.S. 40 to U.S. 101

North of the Distribution Structure in Oakland to El Cerrito Overhead in Richmond, the route is part of U.S. 40 and work on this portion is discussed fully in the U.S. 40 section of this article. Although not yet programmed for construction, a $15,300,000 project is under design study to provide 6.2 miles of six-lane freeway between El Cerrito Overhead and Marine Street in Richmond, near the easterly approach to the Richmond-San Rafael Bridge.

The westerly portion of the route, developed to freeway standards, has been open to traffic between the bridge and U.S. 101 in San Rafael since 1959.

During the past year, two channelization projects were completed with a combined cost of $96,000 in Richmond to allow efficient use of the existing facilities pending development to freeway standards.

Sign Route 21 (Interstate 680) Warm Springs to Martinez

Although a part of Interstate Route 680 utilizes State Sign Route 17 between San Jose and Warm Springs, State Sign Route 21 comprises the major portion of this route connecting the East Bay communities between San Jose and the Benicia-Martinez Bridge.

The route has been adopted between Warm Springs and U.S. 50 near Dublin and design studies are in progress. A 5.5 mile, $6,200,000 project between Mission San Jose and Scott's Corner at Sunol, presently budgeted, will substantially reduce the grade rate over Mission Pass. This project for a four-lane, ultimate six-lane freeway will be ready for advertising late this year.

An aerial mapping contract is now in progress on the 7.6 mile, portion between Scott's Corner and Dublin. On the portion between Danville and Walnut Creek, plans for a $13,500,000, 6.4 mile project will be completed this year. Contra Costa County is scheduled to contribute $500,000 towards improvement of county roads feeding this four lane facility. On the remaining 7.2 mile portion between Dublin and Danville, the route has been adopted and design is well advanced.

In the vicinity of Walnut Creek, 4.2 miles of four-lane and six-lane facility were constructed between Rudgear Road and the junction with Sign Route 24 near Oakland Boulevard. This $8,552,000 contract was written up in the May-June 1960 issue of *California Highways and Public Works*.

A low bid of $3,735,293 was submitted on April 12 on a 4.2 mile, $4,410,000 project for construction of an initial four, ultimate six-lane freeway from the new junction of Sign Route 24 near Willow Pass Road at Concord to the Arnold Industrial Highway north of Pacheco.

The project between the finished freeway at Monument Road and north of Concord Avenue is discussed in the next section of this article.

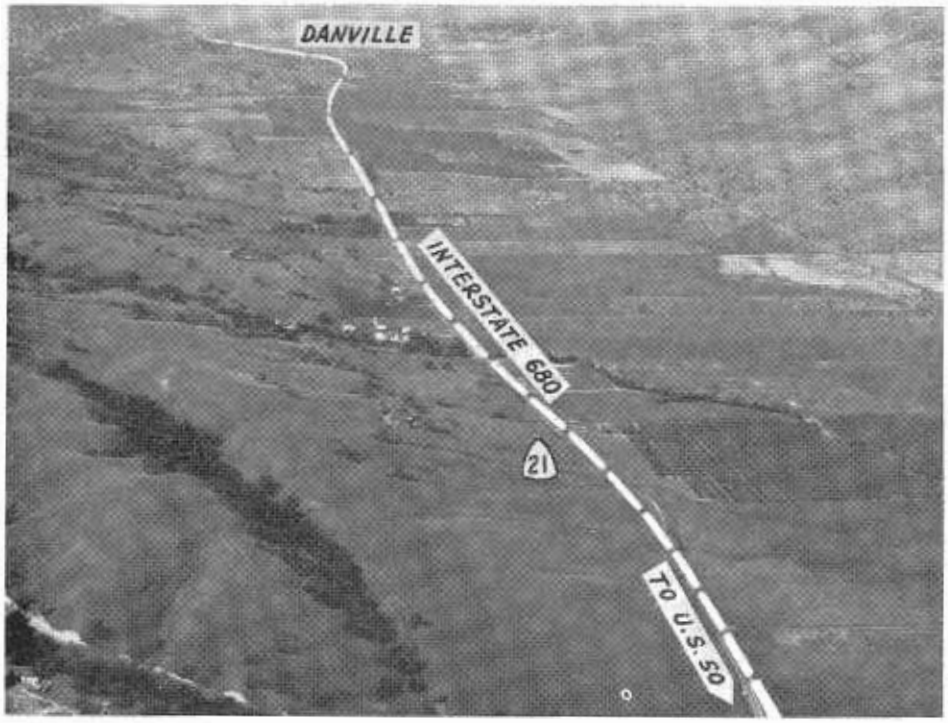
Peter Kiewit Sons Co. is constructing the approach to the Benicia-Martinez Bridge from State Sign Route 4. Three interchanges and two major railroad separations are included in this 3.9 mile $5,131,500 project. This project, with a connection to Escobar Street in Martinez, and the $14,240,000 bridge now under construction, are being financed from revenue bonds authorized by the Legislature in 1952.

Also under way is a landscaping project at the junction of Sign Routes 21 and 24 in the vicinity of Walnut Creek, on which $350,000 is being expended to plant 7,600 cedar, eucalyptus, pine, elm and redwood trees and a ground cover of 68,000 periwinkle plants.

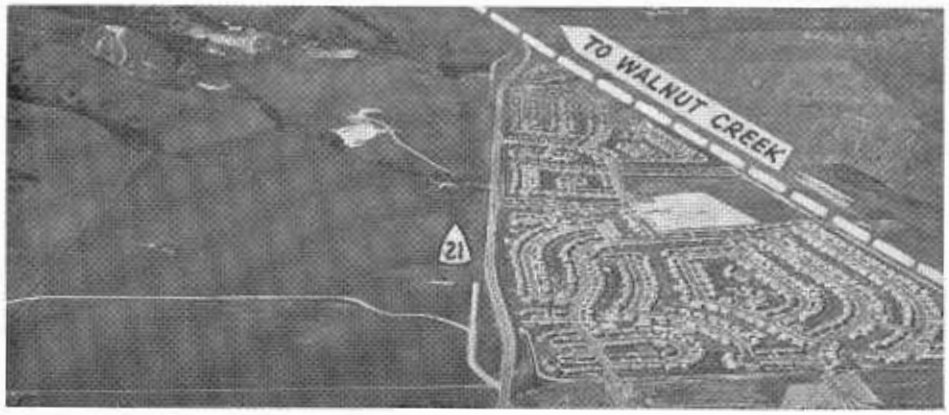
Sign Route 24—Oakland to Sacramento County Line

Sign Route 24 begins at Ashby Avenue Interchange on the Eastshore

Looking north along existing Sign Route 21 showing Danville in the center. Dotted line shows adopted alignment for future construction.



Looking northward along Sign Route 21 from the Alameda-Contra Costa County line toward Danville. The adopted route which generally follows the existing highway is indicated by the dotted white line.



San Ramon Village, looking north from above Dublin Boulevard along existing State Sign Route 21 in Contra Costa County. Adopted routing is indicated by the dotted white line.

Freeway (U.S. 40), proceeds easterly through the Caldecott Tunnel to Walnut Creek, Concord and via the Antioch Bridge to Sacramento.

A related series of six projects are under way in design to provide a direct connection from the Nimitz Freeway to Sign Route 24 and the Caldecott Tunnel. This connection, a portion of which is known as the Grove-Shafter Freeway, will provide 7.1 miles of eight lane freeway at a cost of approximately $37,565,000. Major interchange facilities will be provided at Nimitz, MacArthur and Warren Freeways. Plans are being coordinated with rapid transit studies in this area.

An additional 2-lane tunnel paralleling the two existing Caldecott Tunnels is now being constructed by Connelly-Pacific Co., Grafe-Callahan Construction Co., Brayer Electric Co. and Charles L. Harney, Inc. A more detailed description of this $12,500,000 project is given in the July-August 1960 issue of this magazine.

Completion of the new bore is expected in the late summer of 1963. Alternating the direction of travel in the center bore will provide four lanes to accommodate morning and evening peak traffic and facilitate maintenance operations during off peak hours.

A $7,500,000 project will be advertised this fall to construct 2 miles of eight lane freeway from the east portal of Caldecott Tunnel to the completed freeway at Orinda.

North of Walnut Creek, a 2 mile freeway extension from the completed section at Monument Road will fill the gap in the Interstate Routing between Walnut Creek and the Martinez-Benicia Bridge and will include grading on Sign Route 24 to Concord Avenue. Plans for this initial four-lane freeway are complete and ready for advertising as soon as aqueduct relocation of the Mokelumne lines of the East Bay Municipal Utilities District can be completed. Design studies are under way for the 3.5 mile portion between Concord Avenue and Sign Route 4.

Route 105—San Mateo and Alameda Counties

The first contract for freeway development of this route between Half

Moon Bay on the San Mateo Coast and High Street in Oakland via the San Mateo-Hayward Bridge will be advertised this summer. This 2.3 mile portion between West Hillsdale Boulevard and South Delaware Street in San Mateo will cost approximately $4,800,000. Four lanes will be provided initially with an ultimate six-lane freeway planned for the section between El Camino Real and South Delaware Street. Two additional projects extending to Junipero Serra Freeway on the west and to the San Mateo-Hayward Bridge on the east are being designed.

Plans for reconstructing and widening the San Mateo-Hayward Bridge to four lanes are being made by the Division of San Francisco Bay Toll Crossings and preliminary work is already under contract. A $3,000,000 project to provide 3.4 miles of initial four-lane freeway between the easterly approach and Nimitz Freeway is also being designed.

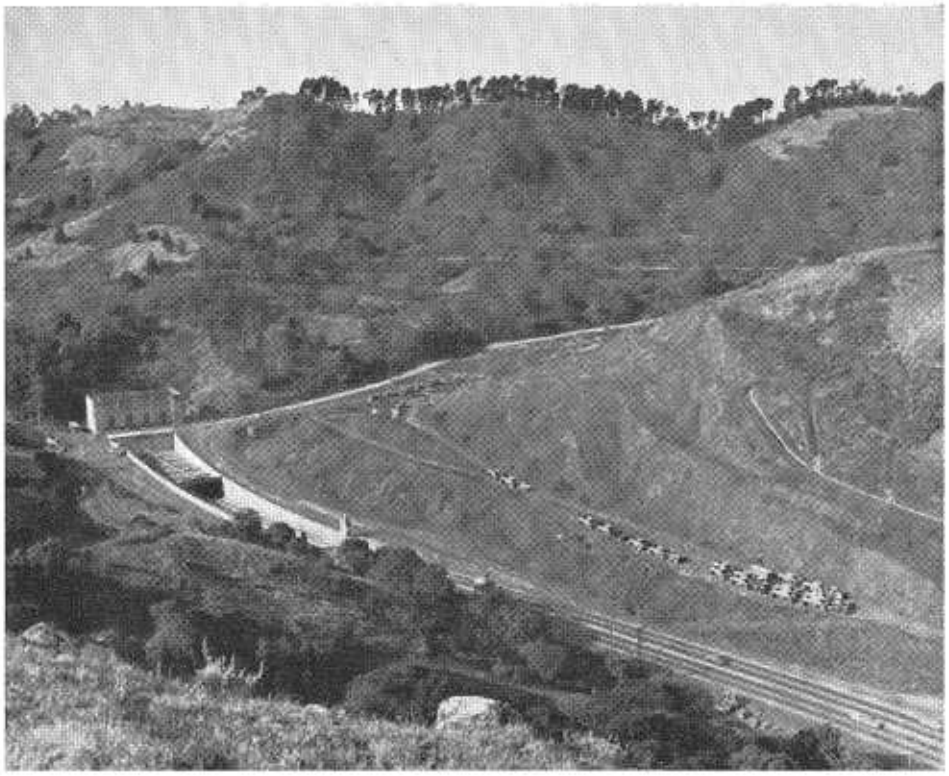
East of Nimitz Freeway, planning studies are well along for freeway development in conjunction with Route 105 and 259 to U.S. 50 near Castro Valley. An interim project for improvement of the existing route along Jackson Street between Harder Road and Castro Street in Hayward will be advertised this summer. Improvement of this 1.6 miles as a conventional four-lane divided highway will cost approximately $2,255,000 and includes a $200,000 contribution to the Alameda County Flood Control District for construction of a dam on Ward Creek in conjunction with the project to eliminate flooding of the highway.

Other interim projects included channelizations and installations of traffic signals and a new bridge across San Lorenzo Creek in the vicinity of Mattox Road and East 14th Street in Hayward. The U.S. Corps of Engineers, Alameda County, and the Alameda County Flood Control District participated in the cost of this $287,000 project.

North of Jackson Street, Route 105 traverses the city street system of Hayward, San Leandro and Oakland.

Route 107—San Gregorio to Sunol

Minor improvements at both ends of the Dumbarton Bridge to widen the roadbed were accomplished during the past year in two contracts totaling $266,000 and studies are in progress for the grading and paving of an improved westerly toll plaza.



The east portal of the Caldecott Tunnel on Sign Route 24 between Oakland and Walnut Creek. Grading is in progress for the additional two-lane bore to be constructed at the right of the existing tunnel.

The route has been adopted and surveys are being made for a future 5.7 mile $6,500,000 freeway between Dumbarton Road in Newark and State Sign Route 9 in the Centerville area of Fremont. As a part of this project, two lanes will be constructed initially easterly to Lincoln Avenue in Newark, with four lanes on the remaining portion.

Preliminary meetings have been held and project studies are being made on a 13 mile section between Junipero Serra Freeway south of Woodside and the westerly end of the Dumbarton Bridge.

A $95,000 interim project for widening and shoulder improvement between Main Street and Sign Route 9 in Fremont was advertised in April. A project for resurfacing between Mission Boulevard in Fremont and Sunol, and a line change in Woodside to avoid a slipout have been financed for early construction.

Mountain View—Milpitas Area

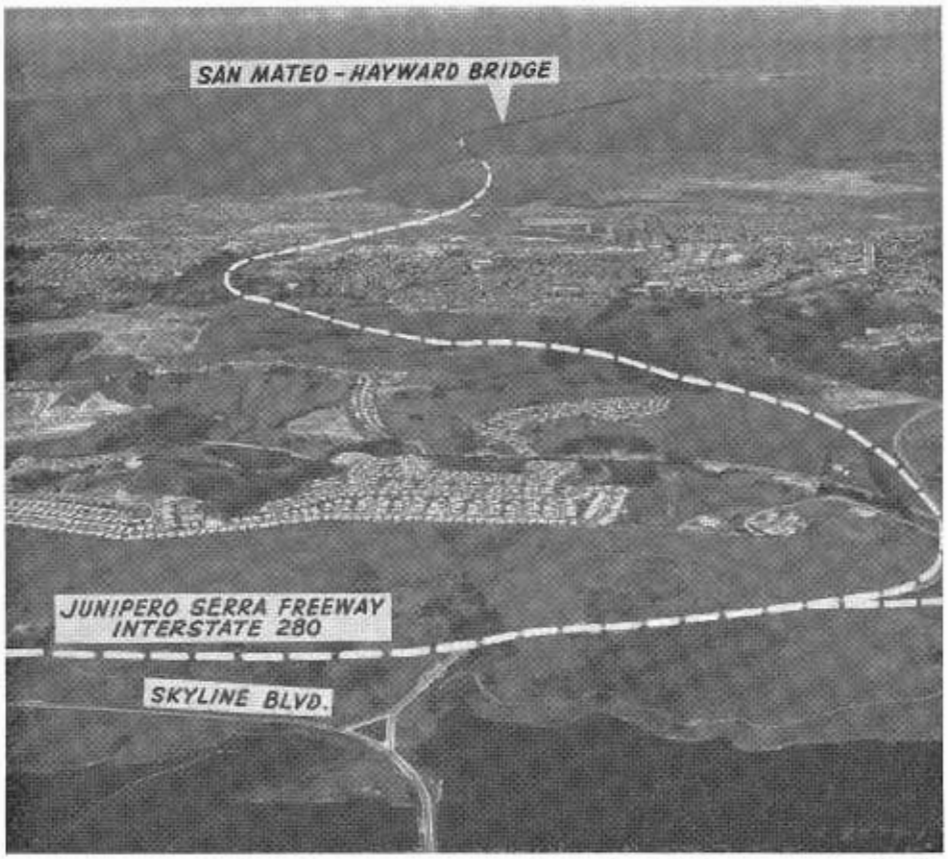
Presently under construction in conjunction with work on the Bayshore Freeway is the initial four-lane development of Sign Route 9 from Bayshore to east of Borregas Avenue, including an interchange at North Mathilda Avenue.

On a 2.3 mile project to construct the northerly 2-lanes of a future four-lane freeway between east of San Jose-Alviso Road and Nimitz Freeway, a low bid of $367,270 was submitted on April 19. This project includes a new Coyote Creek Bridge to replace the present narrow structure with a modern 2-lane bridge on improved alignment.

Design studies are under way for further development of the entire portion between Bayshore and Nimitz freeways.

Route 5—San Jose to Hayward

Project studies are in various stages of progress on the proposed freeway between Bayshore Freeway near Story Road in San Jose and the MacArthur Freeway in Hayward. A California Highway Commission hearing was held April 14, 1961 for the 12.5 mile



Area to be traversed by the 19th Avenue Freeway (dotted line) from the San Mateo-Hayward Bridge (background) and Junipero Serra Freeway (foreground).

portion of the Foothill Freeway between MacArthur Freeway and Washington Boulevard in Fremont and early adoption of the route is anticipated.

An interim widening contract recently completed provides an 80 foot roadbed with 16 foot concrete medians and left turn lanes on Foothill Boulevard between Sycamore Avenue and Gresel Street in Hayward. Traffic signals are also included in this $761,000 project.

Route 108—Sunol to Livermore

The route for an initial four-lane, future six-lane freeway within these limits was adopted November 12, 1960. An interim project to revise the grade and change the alignment between Alden Lane and El Caminito in Livermore, to be jointly financed by the State and Alameda County, is under design study.

Webster Street Tube and Route 226

The contract under way for construction of the second two-lane tube and approaches between Oakland and Alameda is expected to be completed in the fall of next year. Six sections of a total of twelve sections were cast and the first section was sunk into place in April, 1961. A more comprehensive report on this project was printed in the January-February 1961 issue of *California Highways and Public Works Magazine*.

In connection with the tube contract, $360,000 is being expended to place a heavy rock blanket over the existing Posey Tube to prevent displacement. Another $460,000 has been provided for a recently advertised contract to grade and pave storage areas to replace those acquired from the Alameda Army Medical Depot. One other project, to revise lighting and entrances to the existing Posey Tube, will be let when the opening of the new tube permits the temporary closing of Posey Tube for such work.

Warren Freeway (Mountain Boulevard)

Mountain Boulevard was originally developed by Joint Highway District No. 26 which was dissolved in 1954. Since that time, the City of Oakland and Alameda County have each contributed $150,000 per year to match State funds for the development of this four-lane, ultimate six-lane freeway from SSR 24 near Lake Temescal to a connection with the MacArthur Freeway near Mills College.

Funds in the amount of $50,000 have been budgeted for landscaping portions between Broadway Terrace and Redwood Road. Construction is financed for a $700,000 interchange at Moraga Avenue and plans are under way on the remaining $1,500,000 freeway section between Redwood Road and MacArthur Freeway.

Shepherd Canyon Freeway (Route 235)

The route has been adopted and design studies are in progress on the 10.4 mile portion between Warren Boulevard at Park Boulevard Interchange and Sign Route 24 at Pleasant Hill Interchange. Rights of way are being acquired on this initial four-lane, future six-lane freeway. During the 1959 legislative session, Route 235 was extended to provide a continuous route from the Nimitz Freeway near 42nd Avenue to Sign Route 21 near Concord.

Arnold Industrial Freeway (Sign Route 4)

The route for this major east-west freeway in Contra Costa County between U.S. 40 and State Sign Route 21 was adopted in October 1958. The interchange with U.S. 40 near Hercules and a short relocation were completed in 1959 in connection with construction on U.S. 40.

Plans are well advanced for a 4.8 mile portion from Cummings Skyway to East Alhambra Avenue in Martinez. Design is also under way for the projects between U.S. 40 and Cummings Skyway and from East Alhambra Avenue to Willow Pass Road north of Concord.

A contract was awarded recently for the construction of the interchange at the intersection of Sign Routes 4 and 21 near Concord as a part of the freeway construction on SR 21.

From Willow Pass Road to Neroly Road east of Antioch, Sign Routes 4 and 24 are identical. Design studies

are under way for a project within these limits to replace existing grade intersections with interchanges at Bailey Road and Somersville Road. Design of the section from A Street in Antioch to the Antioch Bridge is in progress and rights of way are being acquired.

A $29,000 contract for landscaping the Railroad Avenue Interchange in Pittsburg was completed last year.

Sign Route 37 (Ignacio Wye to Sign Route 128)

Plans for development of the existing 4-lane expressway to a future full freeway status are under way between U.S. 101 at Ignacio Wye and Sears Point, and between the Sonoma-Napa County line and Imola Avenue in Napa.

Between Sears Point and the Sonoma-Napa County line, studies are in progress for a future six-lane freeway.

A $66,400 project for grading and paving portions of the conventional 2-lane highway between 3 miles and 12 miles northeast of Napa was awarded in April of this year. The County is contributing $16,000 for this work.

Sign Route 29 (Vallejo to Lake County Line)

Two projects are presently under construction in the City of Napa. On one, $372,000 is being expended to construct the Sonoma Road Overcrossing with approaches and frontage roads. The second contract ties in with the first and provides an interchange at Imola Avenue and a one mile section of four-lane freeway between the two structures. The County of Napa is contributing $61,000 to the $1,031,000 second project for improvement of drainage in the adjoining area.

From Old Sonoma Road to Union Station, plans are being prepared for three projects to develop an existing expressway to a full freeway. Rights of way are now being acquired.

North of the completed expressway at Orchard Avenue, two projects are being designed to provide a four-lane expressway as far north as Rutherford. The initial two lanes of the section bypassing Yountville were completed in 1959. The route from Rutherford to Ritchie Creek, north of St. Helena was adopted in September 1960.

South of Napa, rights of way are being acquired for development to a six-lane freeway from Imola Avenue to the Solano County line.

Sign Route 12 (Jenner to Napa Junction)

Plans for the first unit of the 17.8 mile four-lane freeway between Sebastopol and Kenwood are nearing completion. This 4.0 mile project between West Occidental Road and South E Street in Santa Rosa is estimated to cost $5,500,000. An interim project is being prepared to provide a four-lane divided section between Farmers Lane and Brush Creek. The City of Santa Rosa will provide the rights of way for this $156,000 project.

Design studies are under way for five projects to complete the freeway between Sebastopol and Kenwood.

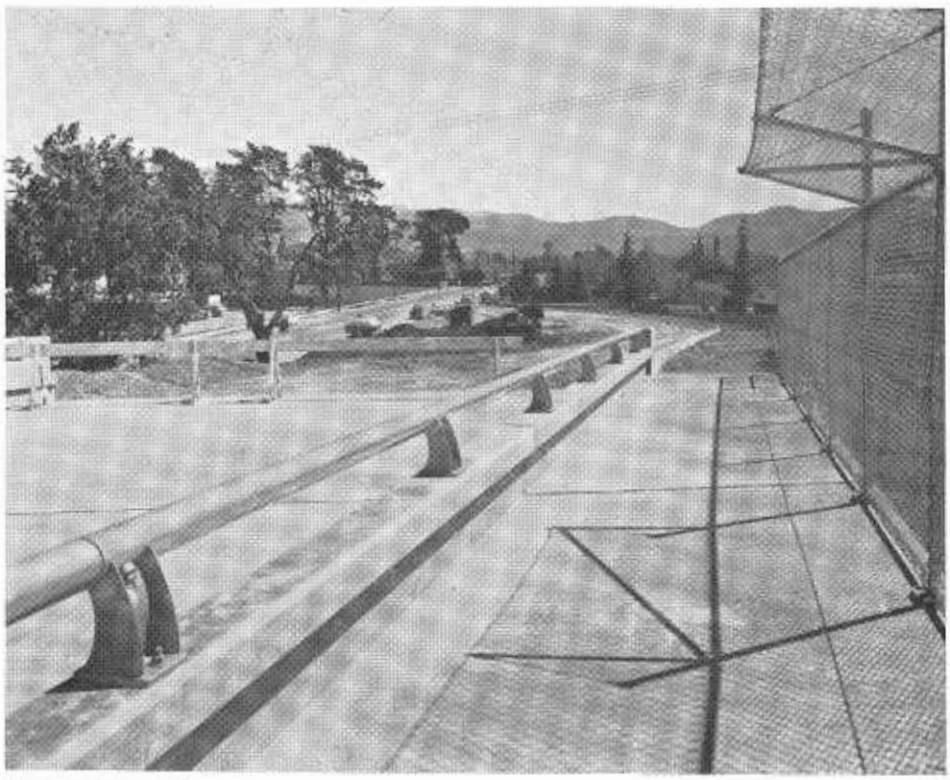
On the westerly end of this route $156,600 was expended last year in the vicinity of Monte Rio for rock slope protection and slipout correction. Funds in the amount of $600,000 have been budgeted for a conventional 2-lane highway on relocation between Duncan Mills and Austin Creek, including a new structure across Austin Creek and elimination of the narrow, steep Duncan Mills grade.

Summary

The past year has seen continued progress toward the realization of a basic freeway network in the San Francisco Bay Area. A broader look at the present freeway picture shows a completed freeway from Los Gatos to the Carquinez Bridge and from Orinda through Walnut Creek. The final link of the Bayshore Freeway between San Francisco to south of San Jose is under construction as is the last section of continuous freeway-expressway from the Golden Gate Bridge to north of Healdsburg.

The twin virtues of safety and beauty continue to play major roles in freeway design and development. The past year has witnessed some 20 projects providing a wide range of functional and aesthetic planting.

Another change has been the appearance of nearly 20 miles of experi-



Chain link fence along the south side of the Old Sonoma Road Overcrossing of Sign Route 29 in the Napa Valley serves both as a railing for the pedestrian walkway and as a deterrent to children dropping objects on cars passing beneath the structure.

mental median barriers on heavily traveled freeways on both sides of the bay. Two types have been used; one utilizes specially mounted metal guard rails and the other consists of steel cables and chain link fence. These reduce headlight glare and virtually eliminate hazard of head-on crashes caused by crossing over the divider. New signs and pavement markings are appearing on some 450 off-ramps to minimize chances of entering freeway lanes in the wrong direction.

The influence of Interstate Highway standards can be seen on all sides; green background for directional signs and mileage markers, the distinctive Interstate Route signs, and the first portions of yellow center stripes.

These changes, superimposed on the growing freeway pattern, reflect and form an integral part of the immensely larger transformation taking place in the Bay Area.

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS

April 1961

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
U.S. 101 AND 101 BYPASS								
Bayshore and James Lick Memorial Freeway, U.S. 101 Bypass; Southern Freeway in San Francisco to Ford Road South of San Jose	52.9	41.4	$48,052,000	11.5	[a]8,673,000	.....	$1,475,000	$25,019,045
Southern Freeway (Incl. Route 253 Ext.)	4.7	.....	[b]7,312,000	1.1	4,072,000	3.1	16,288,000	18,425,370
James Lick Memorial Freeway	3.0	3.0	11,438,000	.....	.....	.....	.....	12,870,444
Central Freeway	1.8	1.8	11,587,000	.....	.....	.....	.....	8,552,000
Golden Gate Freeway	1.1	.....	.....	.....	.....	1.1	5,100,000	70,197
Ford Road South of San Jose to San Benito County Line	27.9	5.8	1,093,000	.....	.....	.....	.....	545,839
Redwood Freeway; Golden Gate Bridge to Mendocino County Line	84.3	55.9	[a]41,583,000	14.9	9,363,000	.....	700,000	16,656,043
U.S. 40								
San Francisco to Carquinez Bridge (portions)	18.2	18.2	[d]61,103,000	.....	.....	.....	319,000	13,222,690
U.S. 50								
MacArthur Freeway; Distribution Structure to Castro Valley	15.3	.....	.....	4.5	16,571,000	6.5	16,700,000	50,337,592
Castro Valley to San Joaquin County Line	31.4	31.4	11,647,000	.....	.....	.....	.....	4,135,000
SIGN ROUTE 17								
Nimitz Freeway; Distribution Structure to Bayshore Freeway at San Jose	41.3	41.3	55,452,000	Add lanes	4,942,000	.....	120,000	22,075,416
Santa Cruz to San Jose (portions)	19.9	17.0	15,783,000	2.9	1,288,000	.....	200,000	9,933,016
U.S. 40 near Albany to U.S. 101 near San Rafael (portions)	9.9	2.4	1,973,000	.....	.....	.....	.....	2,390,775
SIGN ROUTE 9 AND 21								
Warm Springs to U.S. 50	17.7	.....	.....	.....	.....	4.7	6,200,000	793,175
U.S. 50 to Walnut Creek	16.0	3.5	2,910,000	.....	100,000	.....	.....	8,079,441
Walnut Creek to Monument	3.4	3.4	9,104,000	.....	132,000	.....	.....	6,417,774
Monument to Solano County Line	7.4	.....	.....	3.2	[a]6,833,000	4.2	6,210,000	3,531,620
Sign Route 9 North of Route 21 in Fremont	2.2	.....	.....	.....	.....	.....	.....	10,000
GROVE-SHAFTER FREEWAY AND SIGN ROUTE 24								
Sign Route 17 in Oakland to Warren Boulevard	4.8	.....	.....	.....	.....	.....	.....	5,961,751
Warren Boulevard to Walnut Creek	11.0	6.8	9,606,000	1.1	11,703,000	2.0	7,500,000	5,492,582
North of Monument to Sign Route 4, Concord	3.4	.....	226,000	.....	.....	.....	500,000	1,675,321
EMBARCADERO FREEWAY	1.5	1.5	14,792,000	.....	.....	.....	.....	12,284,683
PARK-PRESIDIO FREEWAY; GOLDEN GATE BRIDGE TO FULTON STREET	2.1	1.2	1,448,000	.....	.....	.....	.....	70,000
JUNIPERO SERRA FREEWAY								
Sign Route 17 to San Francisco County Line	43.9	.....	.....	.....	.....	.....	.....	14,096,432
Stevens Creek-West Valley Freeways	23.6	.....	.....	.....	.....	.....	.....	3,614,335
CABRILLO HIGHWAY								
Moss Beach to Lake Merced Boulevard in San Francisco	17.0	5.4	2,766,000	.....	.....	.....	.....	6,307,015
Watsonville to 4 miles South of Davenport (portions)	22.8	12.4	6,929,000	.....	.....	.....	612,000	3,678,068
JUNIPERO SERRA FREEWAY TO NIMITZ FREEWAY								
19th Avenue Freeway, Junipero Serra Freeway to Alameda County Line at San Mateo Bridge (portions)	8.0	.....	.....	.....	.....	4.9	4,800,000	3,533,895
San Mateo County Line to Nimitz Freeway	6.8	.....	.....	.....	.....	.....	.....	450,000

STATUS OF DISTRICT IV FREEWAY AND EXPRESSWAY PROJECTS—Continued

April 1961

Description	Total miles	Completed projects		Under contract		Budgeted		Right of Way expended and budgeted
		Miles	Construction cost	Miles	Construction cost	Miles	Construction cost	
Pacheco Pass: 1 Mile East of Bell's Station to Merced County Line	5.3	5.3	1,285,000					12,393
West of U.S. 101 to Bypass U.S. 101 in Redwood City (Route 214)	1.1							1,700,000
Mountain View—Alviso Freeway; El Camino to Nimitz Freeway	10.5	2.1	1,006,000	0.9	674,000		360,000	1,247,087
Freeway Connection from Nimitz Freeway to U.S. 50 (Route 228)	2.2	2.2	2,803,000					2,236,000
Bay Farm Island Bridge and Approaches	0.6	0.6	2,062,000					165,000
Webster Street Tube	1.1		203,000	1.1	17,363,000		300,000	3,176,725
Warren Boulevard Freeway: Sign Route 24 near Lake Temescal to MacArthur Freeway	5.6	4.1	[5],612,000				550,000	2,043,488
Shepherd Canyon Freeway; Warren Boulevard Freeway to Sign Route 24	10.3							625,963
Arnold Industrial Freeway; Hercules to Antioch Bridge (Sign Routes 4 and 24)	34.1	14.7	4,694,000					1,833,955
Sign Route 12; Sebastopol to Kenwood	17.7							5,375,036
Sign Route 29; Solano County Line to Calistoga	36.9	22.2	3,472,000		372,000		670,000	3,186,157
Sign Route 37; From Redwood Freeway at Ignacio to Napa	13.4	7.2	5,900,000			0.5	300,000	1,205,902
Totals	642.1	310.8	341,841,000	41.2	82,086,000	27.0	68,904,000	283,037,225

(a) Includes $300,000 contributed by cooperating agencies.
(b) Includes total of $1,600,000 by City of San Francisco.
(c) Includes total of $5,000,000 by Golden Gate Bridge and Highway District.
(d) $29,117,000 Toll Bridge Funds in this amount.
(e) $6,833,000 from Toll Bridge Funds.
(f) City of Oakland and Alameda County contributions included in this figure.

BIDS WILL BE OPENED JULY 11, ON SAN MATEO-HAYWARD BRIDGE TRESTLE

The State Division of San Francisco Bay Toll Crossings has advertised for bids on the construction of four and one-half miles of four-lane concrete trestle to replace the easterly portion of the present two-lane San Mateo-Hayward Bridge.

The work will be the second major stage in the bridge widening project. Construction of a mole fill at the eastern approach to the bridge has been under way since early in April.

Approximately $19,000,000 in bridge toll revenue funds is available for the concrete trestle work, according to Norman C. Raab, chief of the Division of San Francisco Bay Toll Crossings.

Bids will be opened July 11 at 2 p.m. in the Division's office, 151 Fremont Street, San Francisco.

The four-lane concrete trestle will traverse the non-navigable portion of San Francisco Bay. It will be at the same low height above the water as the present trestle, and immediately adjacent to it along the north side. Raab explained that the type of steel structure which will be used over the navigational channel, near the westerly shore, has not been finally determined, but that the trestle work is designed to tie in with any type.

The contract will provide for completion of the trestle section in about two and a half years.

Plans call for construction of a two-lane trestle along the north side of the present structure, for removal of the present substandard structure, and then construction of a new two-lane trestle in its place. The construction work will be phased, Raab said, so as to provide four lanes of travel for increasing distances as the job progresses westward.

Total length of the San Mateo-Hayward Bridge is about seven miles.

The Legislature now has under consideration a bill which would authorize a high level fixed-span structure over the navigable portion of the bay in place of the present low-level lift span.

CANADIANS STUDY RIGHT-OF-WAY PROCEDURES

Members of Parliament of the Province of Ontario and staff members visited Sacramento early in May for conferences with State Division of Highways and Department of Public Works officials on right-of-way procedures, laws and policies. Seated at the table (left to right) are S. E. Fennell, Special Counsel to the Committee; A. R. Dick, Chief of the Ontario Department of Highways Legal Section; A. Grossman, Member of the Provincial Parliament and Minister Without Portfolio; William G. Noden, Member of the Provincial Parliament; Fred M. Cass, Minister of Highways and Chairman of the Delegation; Leo Troy, Member of the Provincial Parliament; Hollis E. Beckett, Queen's Counsel; George W. Parry, Charles E. Janes, Gordon W. Innes, and Joseph M. Gould, all Members of the Provincial Parliament; and T. Fred Bagshaw, Assistant State Director of Public Works. Seated away from the table in the left background are (left to right) Harry Fenton and Robert E. Reed, Assistant Chief and Chief of the California Division of Contracts and Rights-of-Way; J. W. Trask, Deputy State Highway Engineer; Harold Barry, Superintendent of Property, Ontario Highway Department and Ellis P. Morningstar, Member of the Provincial Parliament. Standing are J. C. Womack, State Highway Engineer and Robert B. Bradford, State Director of Public Works.

FEDERAL-AID HIGHWAY CONTRACTS TOTAL 7,098 IN CALENDAR YEAR 1960

A total of 7,098 Federal-aid highway and bridge construction contracts was awarded by the State highway departments during 1960, involving a total cost of $3.1 billion. The figures were compiled by the Bureau of Public Roads, U. S. Department of Commerce. The dollar volume of these contracts represents almost a 25-percent increase over the comparable 1959 figure of $2.5 billion.

The contracts awarded in 1960 averaged about $440,000, with the median size about $160,000. They varied from less than $25,000 to over $16 million, with an equitable distribution throughout the entire range. Twenty-six percent of the Federal-aid highway and bridge construction contracts awarded by the State highway departments were for amounts less than $50,000, and 17 percent were between $50,000 and $100,000. Another 22 percent were for amounts between $100,000 and $250,000, and 15 percent were between $250,000 and $500,000.

About 79 percent of the total number of contracts awarded were for amounts less than $500,000 and better than 42 percent were for amounts less than $100,000, indicating that a large proportion of the Federal-aid contracts awarded in 1960 were sized for small business. The Federal-aid highway program thus appears to be favorable to the existence and prosperity of both large and small contractors. This is in consonance with the declaration by Congress in Federal-aid legislation that it is in the national interest both to encourage and develop the actual and potential capacity of small business in connection with the prosecution of the highway program.

A tabulation of the contract figures follows. Included among the contracts are 695 for miscellaneous specialty projects, such as seeding, signing, or lighting, most of which are included in the two lowest sized groups.

U.S. 80 - San Diego

Another Eight-lane Section is Completed

By MARK E. DARROUGH, Highway Engineering Associate

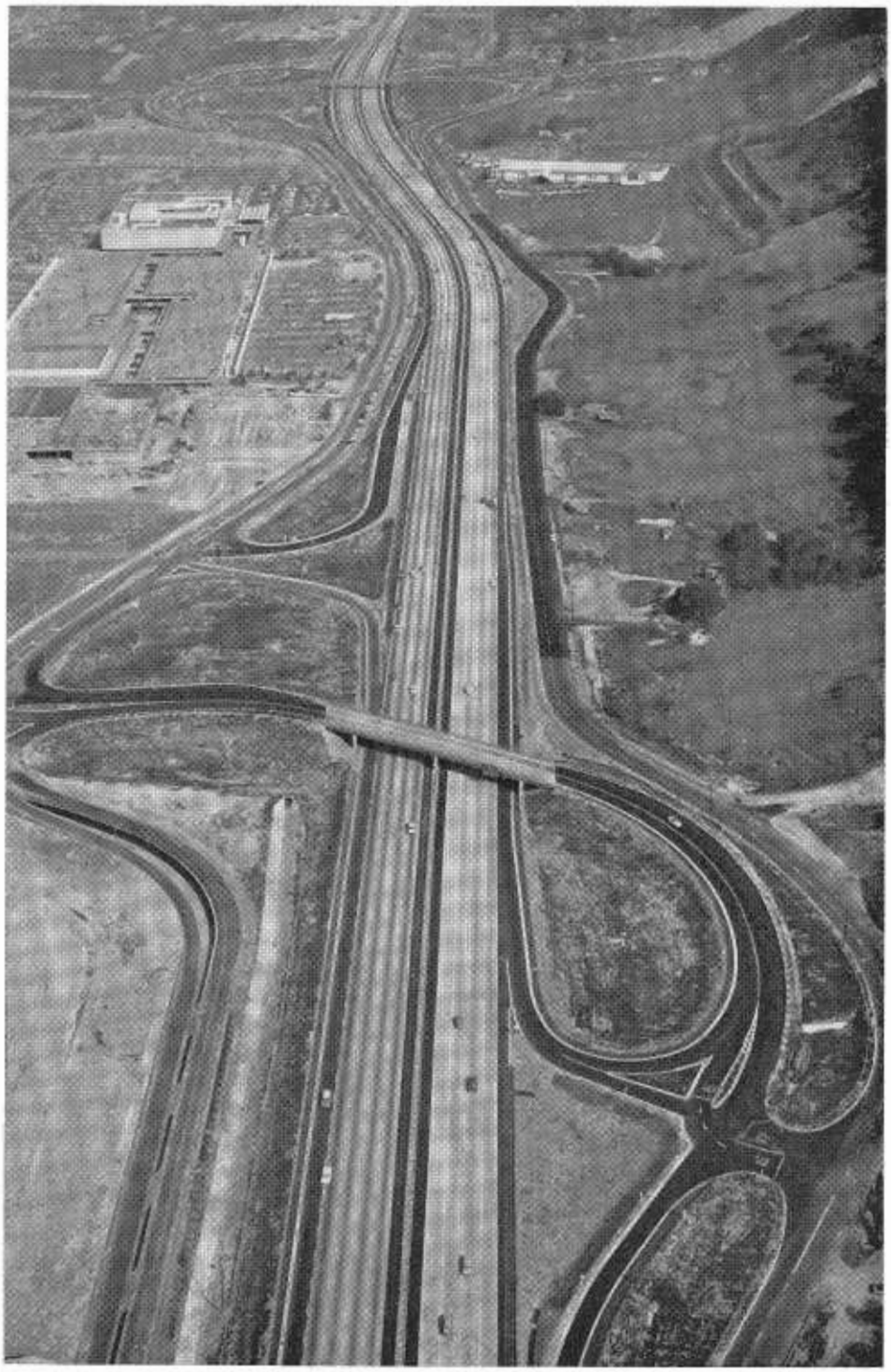
WITH THE completion of another major U.S. 80 freeway contract through the Mission Valley area of the city of San Diego on December 23, 1960, another major step was taken toward the culmination of a six-year freeway construction effort to place in operation a major transportation complex with westerly terminus at U.S. 101 in the city of San Diego and extending to the easterly end of the El Cajon Valley, a distance of 17 miles.

This 3½-mile, eight-lane freeway section of the National System of Interstate and Defense Highways extends easterly from the U.S. 80/U.S. 395 interchange to Fairmount Avenue and was constructed by the R. E. Hazard Contracting Company and W. F. Maxwell Company at a cost of approximately $4,500,000.

In addition to the full eight-lane facility, the work also included construction of frontage roads on each side of the freeway; interchanges at East Cabrillo, Texas Street, and Ward Road; and two parallel two-lane bridges over the San Diego River, which join the county's Murphy Canyon Road.

Two-phase Construction

The freeway was constructed basically in longitudinal halves. The new westbound lanes were constructed first while traffic utilized the existing facility. Upon completion of the new westbound lanes, traffic was shifted thereon and the new eastbound lanes were constructed on approximately the same alignment as the old roadbed. This basic plan of construction has been mandatory on a majority of the freeway contracts on U.S. 80, inasmuch as the new construction has substantially followed the old alignment



The El Cabrillo Overcrossing on U.S. 80 in San Diego. The view is eastward.

Looking eastward on U.S. 80 showing Morena Boulevard (overcrossing and bridge foreground) and Taylor Street (joining U.S. 80 from the right).

and no alternate routes were available. This not only has required the use of the basic half-width construction plan but has caused extensive staging and phasing of construction operations and some curtailment of operations during certain peak traffic periods in order that the traveling public would be subject to a very minimum of delay during the construction period.

In addition to handling heavy volumes of through traffic, it was also necessary to phase all operations so that moderately heavy volumes of traffic on major intersecting city streets could be handled efficiently and with a minimum of delay during construction. In short, almost every freeway contract on U.S. 80 has been completely geared, construction-wise, to the needs of the traveling public, and at no time could any alteration in staging or phasing be made in construction operations until it was determined that public traffic would be equally or better served by the change.

Last Section

The aforementioned 3½-mile freeway contract was the last to be constructed, but roughly in the geographical center, of the seven freeway contracts which comprise the first ten miles of this U.S. 80 development which extends from U.S. 101 on the west to the city of La Mesa on the east. The six other contracts, in their geographical order, which comprise this ten-mile section of the complex, are as follows:

The first extended from U.S. 101 to U.S. 395, totaled 1.3 miles of eight-lane freeway, and was constructed by R. E. Hazard Contracting Company and W. F. Maxwell Company at a cost of $1,300,000. One overcrossing structure was built at the westerly end of the project at Presidio Park and frontage roads were constructed on each side of the freeway.

The second contract entailed extensive revision of the existing U.S. 80/U.S. 395 interchange to provide for full eight-lane construction for U.S. 395 as well as U.S. 80. This work was performed by the Griffith Company at a cost of $3,500,000.

The third contract was the three-and-a-half-mile, eight-lane section previously referred to.

The fourth contract encompassed the construction of an interchange at the intersection of a major city street, Fairmount Avenue. This one-mile section of six-lane freeway was constructed by the Griffith Company.

Fifth Contract

The fifth contract, also a six-lane freeway constructed by the Griffith Company, extended from Fairmount Avenue to 1.1 mile west of 70th Street. Interchanges were constructed at Waring Road and College Avenue, which are major city streets serving growing residential areas and commercial developments.

The sixth contract, again a Griffith Company project of six-lane design, extended from 1.1 mile west of 70th Street to 0.6 mile west of Fletcher Parkway. A city arterial also, 70th Street (Lake Murray Boulevard) was integrated into the freeway improvement by the construction of a major interchange at this intersection.

The seventh contract served to terminate the first ten-mile section of freeway into an interchange connection of U.S. 80 and the County-constructed Fletcher Parkway in the vicinity of La Mesa.

These ten miles are the backbone of a highly important transportation system connecting several city and county arterials. These arterials extend both north and south from U.S. 80 freeway interchanges into the major residential and commercial areas of East San Diego and the city of La Mesa, including the mushrooming new residential developments within these areas and the major industrial areas of Kearny Mesa and Mission Valley.

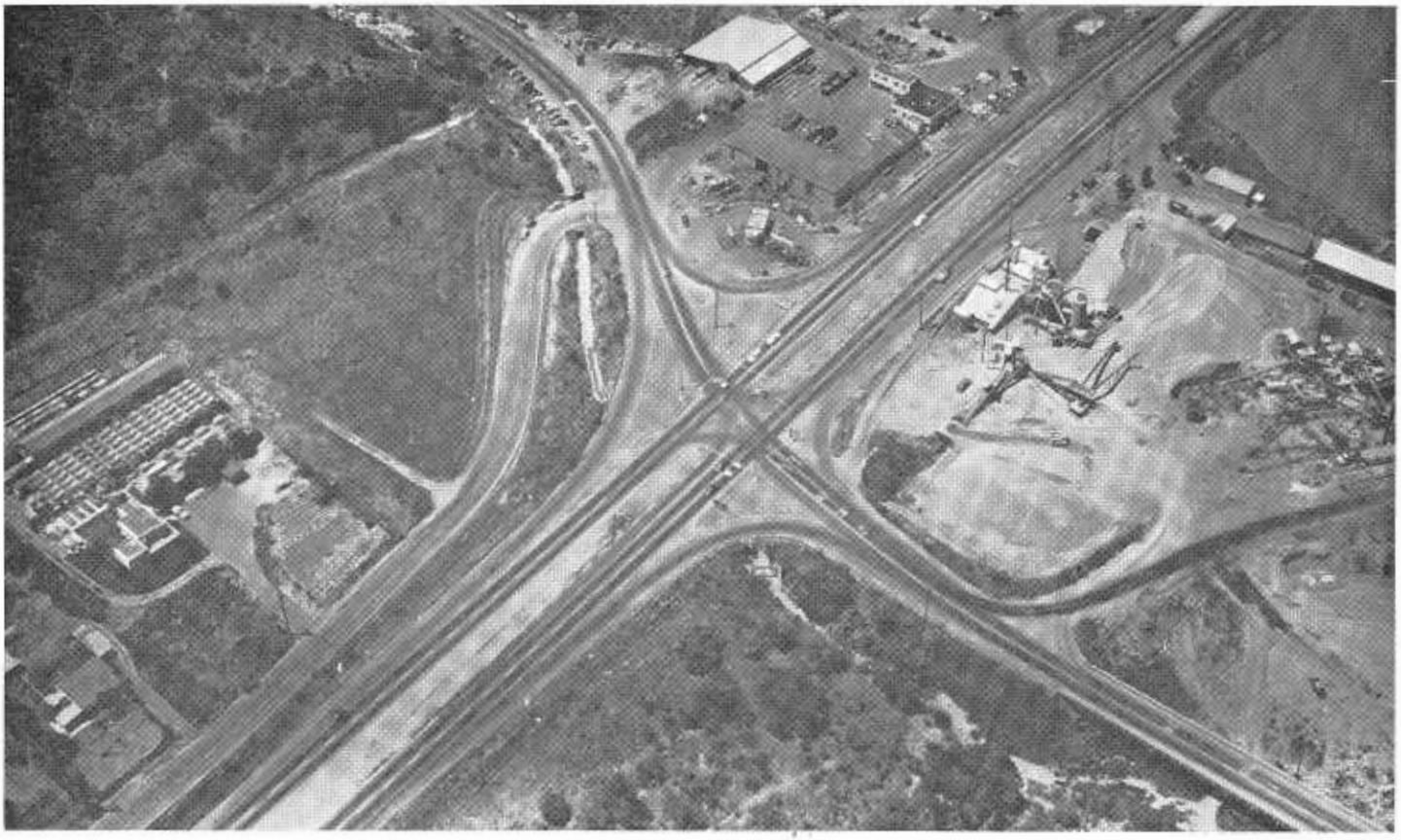
Evidence of Importance

The importance of this freeway section is evidenced by the six- to eight-lane construction, the 60,000-vehicle average daily traffic, and is further evidenced by the rapid improvement of major city and county intersecting highways to four-lane freeway or expressway standards.

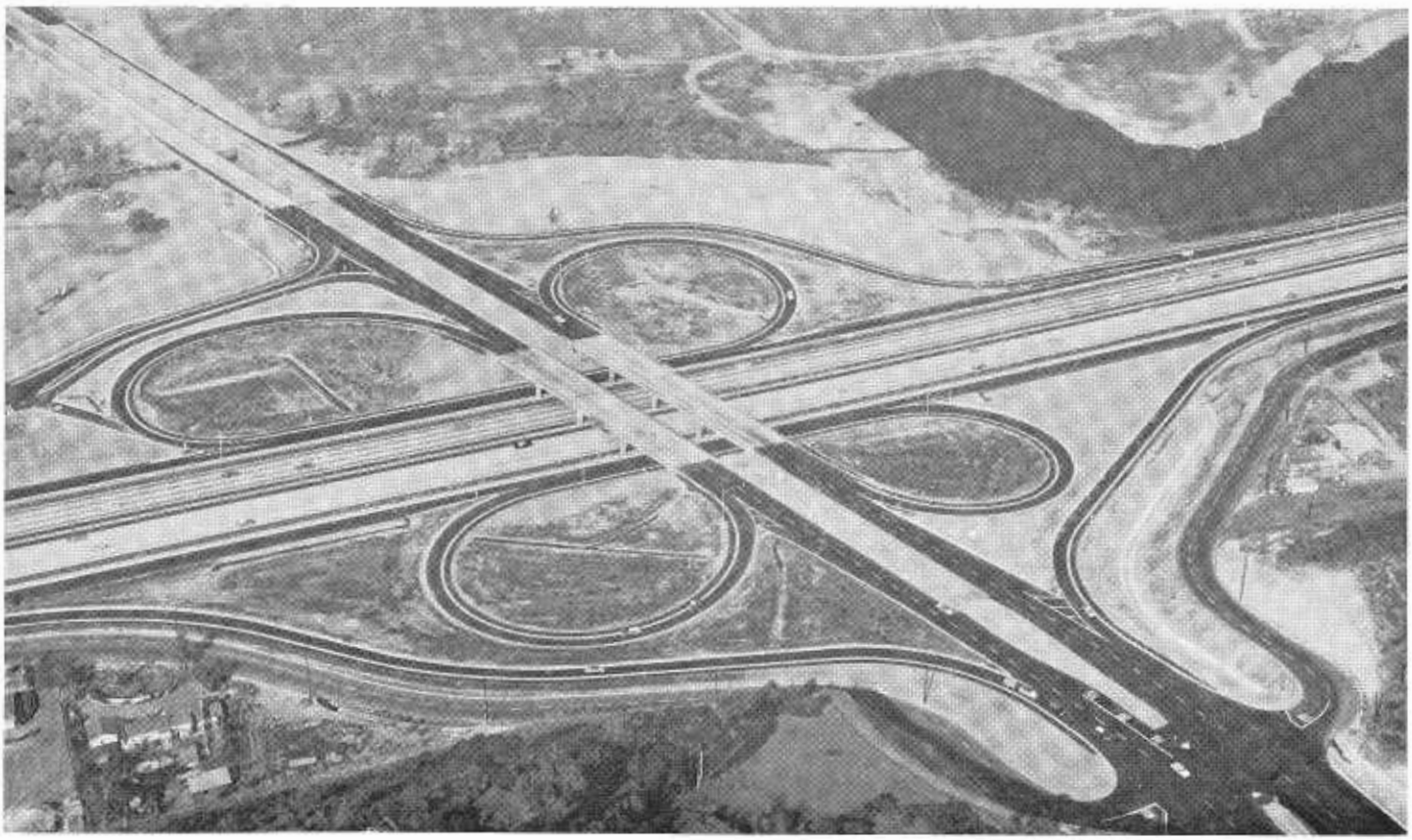
Recently completed improvement on major city arterials which connect a majority of the East San Diego area to the U.S. 80 freeway and adjacent commercial developments, are as follows:

Texas Street was realigned and widened to three lanes between Adams Avenue and U.S. 80.

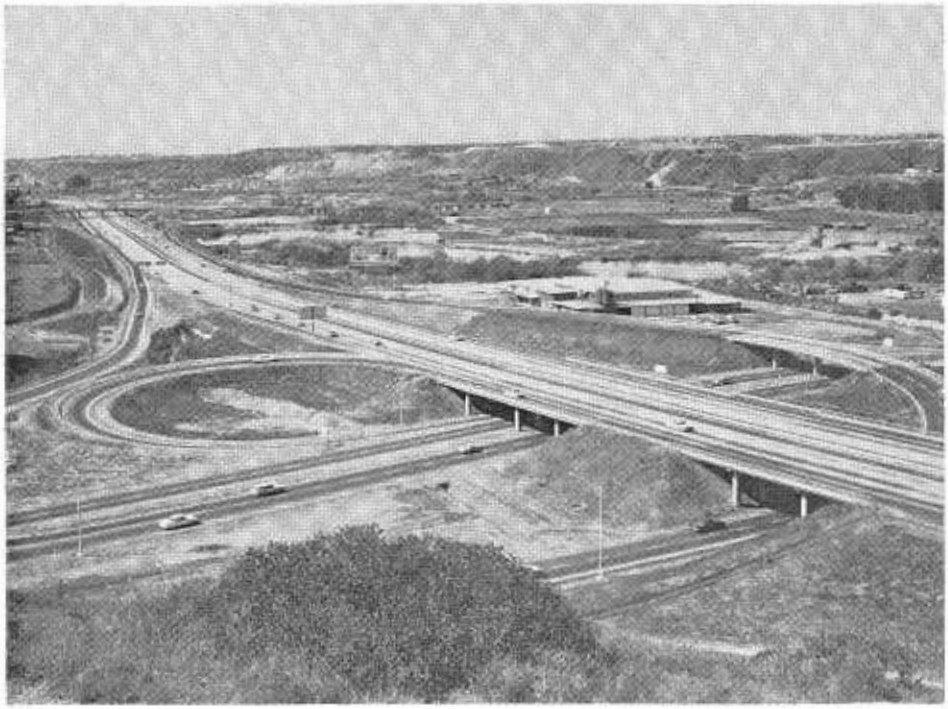
A major improvement was made from U.S. 80 south to Madison Avenue on Ward Road. The original



BEFORE. An aerial view of the Ward Road-U.S. 80 intersection taken in 1955.



AFTER. The new Ward Road-U.S. 80 freeway interchange, vintage 1961.



The Fairmount Avenue-U.S. 80 interchange, looking northwest.

winding two-lane road was completely reconstructed into a four-lane full freeway and designed for possible expansion to six lanes.

Fairmount Avenue was also given the full freeway treatment between U.S. 80 and Monroe Avenue, plus the improvement of the easterly bearing Montezuma Road to four lanes divided and the construction of an interchange at the Fairmount-Montezuma intersection.

Waring Road, College Avenue, and 70th Street were all improved in alignment and grade and reconstructed to multi-lane freeway, or expressway standards.

First Major Expressway

While the City of San Diego has been concerned, in the main, with improvements south of U.S. 80, the County of San Diego has had the responsibility of a majority of the major roadway improvements to the north. In fact, the County was the first to complete a major expressway which ties into this east-west arterial, namely, the Fletcher Parkway, which intersects U.S. 80 at an interchange at the easterly end of this ten-mile freeway section.

At present the County has under contract the reconstruction of Murphy Canyon Road between U.S. 80 and U.S. 395. The work is being done by the Daley Corporation and when completed will provide a four-lane expressway connection between the Kearny Mesa industrial area adjacent to U.S. 395 and U.S. 80 at the Ward Road interchange.

The newly completed freeway section does not appear to be limited to serving only existing centers of residential population and commercial and industrial development, however. It is quite evident that it is becoming the nucleus around which extensive retail and commercial expansion is forming.

Many motels and restaurants have been constructed westerly of the U.S. 80/U.S. 395 interchange, and development along U.S. 80 easterly of this intersection has been pioneered by major commercial development in the vicinity of the Texas Street, College Avenue, and Fairmount Avenue interchanges, while large shopping centers have appeared in Mission Valley and at Grossmont. In addition, many other large developments are still in the planning stages.

Four Contracts

The remaining seven miles of this 17-mile interstate freeway are divided into four construction contracts, the last of which is scheduled for completion in February 1962. One of these contracts has already been completed and is located in the Grossmont Summit area. This project included an interchange tie-in between U.S. 80 and State Sign Route 67 and, at the easterly end of the project, began the initial departure from the old existing alignment and commenced the relocation of U.S. 80 to the western slopes of El Cajon Valley.

The next two contracts, one of which has just been completed and the other scheduled to be completed by mid-1961, will further extend the six-lane relocation of U.S. 80 along the western slopes of the valley and thence bypass the main business district of El Cajon to the north and terminate at Third Avenue in El Cajon—the end of this 17-mile 29-million-dollar freeway project.

The last contract to be completed, and out of geographic sequence, is located between the previously completed projects at 70th Street and at Grossmont Summit. This 2.3-mile project is scheduled for completion early in 1962 and calls for partial reconstruction of the U.S. 80-Fletcher Parkway interchange and the construction of an interchange connection to El Cajon Boulevard, another major La Mesa city artery.

Upon completion of this final contract, the entire 17 miles of freeway transportation complex will then commence operating as a composite unit and will, with the necessary assistance of improved city and county thoroughfares, serve all adjoining areas from U.S. 101 and Kearny Mesa through Mission Valley and Alvarado Canyon to eastern El Cajon Valley.

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63 BIDS ADVERTISED

During April the Department advertised for bids on 63 highway projects with an estimated value of $31,797,800. Since January 1, 1961, projects for $131,876,200 have been advertised. There were 55 contracts awarded during the month.

During April bids were opened for 49 projects for which 296 contractors' bids were received, an average of six bidders per project.

U.S. 199 Tunnel

Work Begins on Relocation Of North State Highway

By PAUL E. PARKER and H. L. PAYNE, Senior Bridge Engineers

CONSTRUCTION of the new mountain tunnel on highway U.S. 199 at Hazelview Summit, between Crescent City and Grants Pass, Oregon, has now begun. The contractors are The Grafe-Callahan Co. of Los Angeles and the resident engineer is George Jochim.

This tunnel, which is estimated to cost $3,788,000, exclusive of approaches, makes possible the 4.3 mile highway relocation described by L. R. Redden in the September-October, 1960, issue of *California Highways and Public Works*. The new highway replaces a steep narrow road with eight hairpin curves. The new alignment pierces Hazelview Summit Ridge 340 feet below its crest with a sixty mile an hour alignment that has a six percent maximum grade. An elevation view of the tunnel is shown in the accompanying illustration.

Driving of the pilot bore at the north portal of the new Hazelview Tunnel, part of a realignment project on U.S. 199 in Del Norte County.

Tunnel Description

The tunnel is 1886 feet long, provides two traffic lanes, and is 26 feet between curbs, with two 2'-4" sidewalks. A 15-foot vertical clearance is provided for traffic. This 15-foot clearance is maintained at the portals with timber grade beams which ensure that high loads will not brush the lighting fixtures that run along each edge of the ceiling.

The bore is on a straight alignment. This is an advantage in tunnel construction and was achieved at some expense in the approach grading work. A horizontal curve that ends just ahead of the south portal carries some superelevation into the tunnel, and the tunnel arch is warped upward there to maintain adequate vertical clearances with a minimum typical section in the remainder of the bore. This warping upward of the arch saved about $32,000 compared to the alternative of using a larger tunnel cross section.

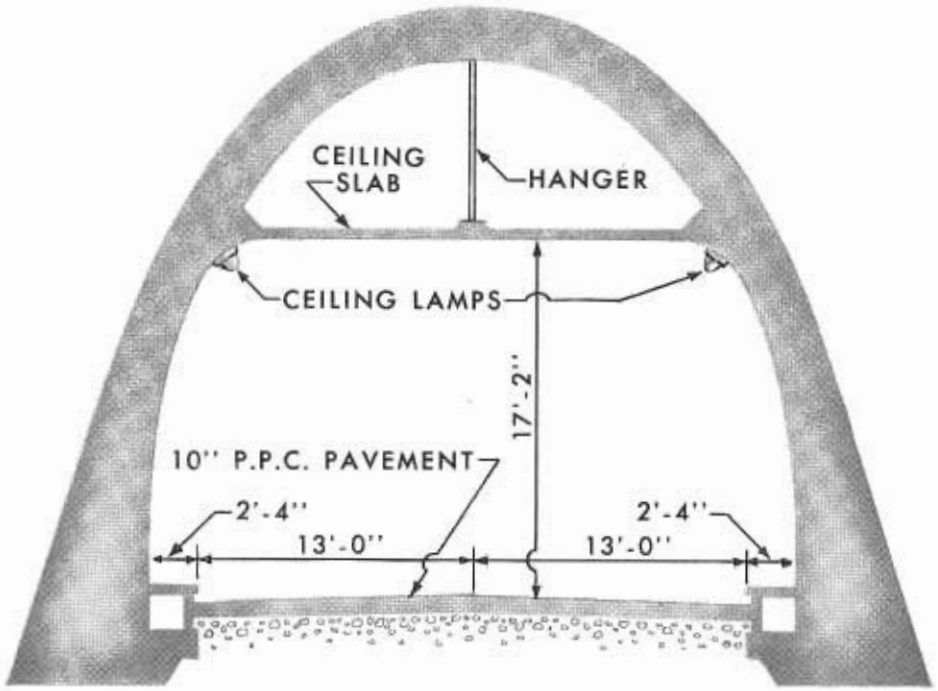
The roadway is on a straight grade of three percent, draining towards the north portal. This grade was selected by a study that took account of minimum desirable truck speeds on the uphill grade. The three percent grade also aids tunnel drainage during construction and operation.

Lighting is conventional, using a single continuous line of fluorescent tube fixtures along one side of the tunnel and a second line on the opposite side near each portal. The lighting design will provide illumination of 45 foot candles at the portal zones and 7 foot candles in the tunnel interior during daylight hours. Nighttime illumination will provide 1.7 foot candles throughout the tunnel and street light illumination beyond the portals.

Light Is Reflected

Reflection of light in the tunnel will be aided by a white epoxy paint applied to the walls and ceiling. The gloss surface provided by the paint film will also aid washing. The use of paint on the walls and ceiling rather than ceramic tile was estimated to save about $175,000 in initial cost, and should provide adequate service at this site.

An automatic mechanical ventilating system is also being installed. At first it appeared that the moderate tunnel length, combined with the light initial traffic volume, might allow dependence on natural drafts for ventilation. However a long term barometric pressure and wind direction data needed for reliance on natural ventilation were lacking at this site. This, coupled with the estimate that future traffic growth would defi-



SECTION
HAZELVIEW SUMMIT TUNNEL

nitely require mechanical ventilation, prompted the decision to install a ventilating system during initial construction.

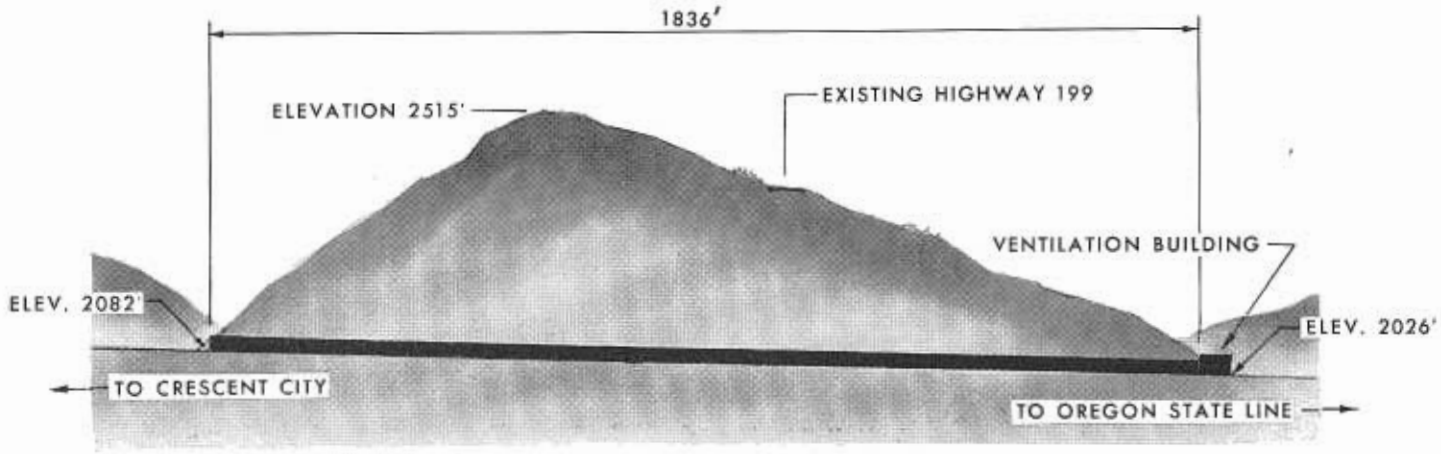
The ventilating system admits fresh air through the portals of the tunnel, and draws exhaust air through ceiling ports into a longitudinal duct running above the roadway for the length of the tunnel. The ceiling ports are arranged to provide varying exhaust capacity along the length of the bore, with the most exhaust capacity at the north end of the tunnel in anticipation of eventual conversion of the tunnel to one-way traffic. Exhaust air in the ceiling duct is withdrawn by propeller type fans into vertical stacks in the ventilation building at the north end of the tunnel. The fans are designed to exhaust 180,000 cubic feet per minute and maintain the carbon monoxide content of air in the tunnel below 4 parts in 10,000. The fans are actuated by recording carbon monoxide analyzers that continually sample air from four points in the tunnel. The system is designed to operate automatically with a minimum of maintenance.

Structural Design

The structural design of a tunnel depends on the character of the ground it penetrates. This tunnel penetrates highly folded, partly metamorphosed rock. It consists mostly of thinly bedded slaty shale, siltstone, and interbedded fine sandstone that is generally crushed and shattered. The beds have a steep dip, and trend in the same general direction as the tunnel. This is generally poor ground for tunneling.

The concrete liner selected to support the loading generated by this rock is an approximately parabolic arch, standing thirty-two feet high and 30'-8" wide at the spring line, shown in the accompanying illustration. The maximum design load on the arch was determined to be 100 feet of overburden, using Terzaghi's criteria. When the ratio of lateral pressure to vertical pressure is one to three the arch stresses are entirel axial and the maximum concrete stress is 655 psi, a low value. The arch is also reinforced to support in bending various conditions of unsymmetrical loading at design stress. Additional overload capacity is also available when the resistance of the walls of the tunnel to outward displacement comes into play.

The concrete liner is supported on wide footings that exert a maximum pressure on the foundations of twelve



PROFILE
HAZELVIEW SUMMIT TUNNEL

tons per square foot. If soft spots are encountered or horizontal squeezing occurs, a concrete strut slab is provided that can operate to carry both vertical loads and horizontal thrusts. The footing block is also designed to act as a continuous beam when it stands alone in the side drifts during the first stages of tunnel excavation.

One Liner Design

Only one liner design is provided for this tunnel. In many tunnels two or more designs, with different thicknesses for different ground and loading conditions, are used. In this case, it was determined that the simplicity of a single pattern for excavation, placing of structural supports, reinforcement, and concrete more than outweighed possible saving that might be realized by varying the liner design.

Encased in the concrete liner are structural steel arches called tunnel sets which support the tunnel roof between the time the tunnel is excavated and the time the concrete liner is poured. Steel tunnel sets of various strengths were designed as part of the contract plans. The Contractor is given the responsibility for providing adequate support and also the right to redesign the sets to best fit his operating methods and the ground conditions actually encountered.

Water seepage is always an important concern in highway tunnels, and considerable effort is made to provide adequate drainage here. Water seeping down through the rock towards the tunnel will encounter drainage holes drilled into the rock at about fifteen foot centers around and along the arch. Water that may penetrate the concrete liner in the upper part of the tunnel will fall onto the ventilation duct floor slab, which will have a waterproof surface and a drainage system. Water from these drains will be collected in longitudinal flumes lying below the sidewalks. Seepage water coming up from the floor of the tunnel will be drained through a blanket of filter material to longitudinal perforated pipe drains that lie below the pavement base course.

The structural design also considers snow and ice loadings. The ventilation building roof is designed to support the load of six feet of snow, the maximum snow depth recorded at the site. The ventilation duct floor slab likewise will support the ice load that would come upon it should the ceiling drains freeze.

Looking northeast along the completed rough grade of the north approach to the Hazelview Tunnel. North portal of the tunnel is hidden by the trees (left center). The big fill is across Broken Kettle Creek.

Construction Controls

Challenging problems also were presented by the time sequence of the contracts involved in construction of the project. Three major contracts are involved: roadwork north of the tunnel, the tunnel itself, and roadwork south of the tunnel combined with paving of the entire project. These contracts were overlapped to avoid an unreasonably long construction period.

The roadwork contract south of the tunnel was synchronized with the tunnel contract. At the south portal the tunnel daylights into a roadway cut, never reaching the original ground surface. Accordingly, the approach contract will require that the south portal be excavated before the tunnel contractor reaches it with his full-section tunnel excavation.

Assuming that the tunnel contractor would begin excavating from the north portal to take advantage of the gravity drainage in the tunnel provided by the roadway grade, and esti-

This northward view of the relocation of U.S. 199 shows the present highway and some of the clearing work being done on the new alignment.

mating that only one heading would be worked, sufficient space was left in the embankments of the north roadway contract to take all of the tunnel spoil.

The tight schedule also required letting the tunnel structure to contract before the tunnel mechanical and electrical work had been detailed. The tunnel mechanical and eletcrical work, except for items embedded in the tunnel lining, will be let as a separate contract that will overlap the tunnel structural work and be completed at the same time.

Future Outlook

An outstanding characteristic of tunnel work is the persistent difference between the prediction of underground conditions and the actual conditions encountered during construction. This characteristic exists because even the best underground exploration program gives only a rough indication of the character of the ground. Excavation is just beginning at this tunnel, and major difficulties have yet to present themselves. The story of the construction of this tunnel will be presented in a future article.

Division Asks Bids On U.S. 50 Freeway

The State Division of Highways has called for bids on a major freeway project on U.S. 50 in El Dorado County.

The project involves grading and surfacing to construct 2.8 miles of four-lane freeway on U.S. 50 between four-tenths mile west of Perks Corner and Placerville.

A total of $3,200,000 in state highway funds is available for the project.

The project includes construction of a bridge over Webber Creek and interchange structures at the El Dorado County Fairgrounds and west of Canal Street in Placerville.

Much of the new freeway will be on more direct alignment south of the existing route. Resurfacing of the existing highway is included in the project.

This project and another current job will complete seven miles of four-lane freeway and expressway through Placerville.

Construction Costs Maintain Stability

The California Highway Construction Cost Index for the first quarter of 1961 stands at 229.6, an increase of 1.1 index points or 0.5 percent over the fourth quarter of 1960. This small increase, together with the small fluctuations during 1960, continues to reflect the period of stability in prices which started during the last quarter of 1959.

Bidder competition during the first quarter of 1961, with an average of 6.1 bidders per project, is almost unchanged from the previous quarter (6.2).

The trend toward stabilization in highway costs is also indicated by the Bureau of Public Roads Composite Mile Index, which is based on Federal-Aid highway construction contracts awarded by the State highway departments. For the fourth quarter of 1960, the latest available, it now stands at 224.4, a decrease of 2.7 points or 1.2 percent. This index has shown small fluctuations during the past year.

The Engineering News-Record Construction Cost Index for the first quarter of 1961 also increased slightly and now stands at 344.8, an increase of 1.8 points or 0.5 percent over the previous quarter.

The annual average of the Engineering News-Record Index reflecting the cost of basic material and labor, has increased 13.8 percent in the last three years, while the Bureau of Public Roads Composite Mile Index has dropped 5.5 percent and the California Highway Construction Cost Index has dropped 12.0 percent during the same period, evidence of continued improvement in equipment and construction methods and also continued strong competition in the highway construction field.

The California Highway Commission has allocated $300,000 for slide removal and installation of a culvert on U.S. Highway 101 adjacent to Long Valley Creek about two miles north of Longvale in Medocino County.

NASH TO HEADQUARTERS; FOLEY, SHERVINGTON NAMED

The transfer of District Engineer A. M. Nash of District V, California Division of Highways, to a special assignment in Sacramento Headquarters office and the transfer of District Engineer E. R. Foley from District IX, Bishop, to replace Nash at San Luis Obispo were announced by State Highway Engineer J. C. Womack. Womack also announced the promotion of Charles A. Shervington of Eureka to succeed Foley.

Nash has been in charge of District V since February, 1956. He has been with the Division of Highways for 41 years.

A. M. Nash

Womack said that Nash's special assignment will involve a statewide study to develop detailed information concerning engineering costs, engineering productivity and uniformity of engineering methods as applied to the Division's planning and construction program. The assignment is expected to last for 12 to 18 months. His position carries the newly established title of Systems Research Engineer.

"The purpose of this study," Womack added, "is to produce more highway for the taxpayer's dollar through the greatest possible uniformity in engineering methods and keeping engineering costs at a minimum. Part of the study has been made, but we have not been able to complete it in view of the heavy and increasing workload in all our departments.

E. R. Foley

"We are fortunate in having been able to persuade 'Pete' Nash to postpone his scheduled retirement date to do this job. He has been selected for this assignment because of his long and varied experience and proven ability."

In the course of his 41 years with the Division of Highways, Nash has worked in four of the Division's 11 districts, serving as District Engineer in three of them (Eureka, Marysville, San Luis Obispo), in addition to three tours of duty in Headquarters office in Sacramento. From 1946 to 1949 he was Engineer of Design for the Division.

Nash is a native of Elk City, Kansas, was educated in Idaho and Washington and at the University of Washington. During World War I he served as a second lieutenant in the Army Aviation Service. He joined the Division of Highways in 1920 as a draftsman and computer.

Nash is a past vice president of the Western Association of State Highway Officials and has served on important national committees concerned with highway design and construction.

Foley, who was appointed District Engineer at Bishop in June, 1956, has been with the Division since his graduation in civil engineering from the University of California in 1932, except for four years with the Seabees during World War II. He is a native of Nevada City.

C. A. Shervington

Most of Foley's early career with the Division of Highways was in bridge construction work. From 1950 to 1956 he was in charge of the statewide county road inventory and mapping program which the State carried on in cooperation with the various counties.

Foley is a member of the American Society of Civil Engineers and of the Rotary Club. He is a commander in the U.S. Naval Reserve. He has also been active in Boy Scout work. He and his wife, Josephine, have two children, Dennis, age 15, and Lynn, age 12.

He will report to District V on May 8 and assume charge of the district effective May 12.

Shervington has had 30 years of service with the Division of Highways, all of it with District I, which covers northwestern California with headquarters at Eureka. He started as a draftsman and rose through the ranks to become Assistant District Engineer in charge of planning in 1951. He has served in this position until his current promotion.

He was born in London, England, moved soon thereafter to Canada, and grew up in Oakland, where he attended the Polytechnic College of Engineering. During World War II he served in the Pacific with the U.S. Naval Reserve Civil Engineer Corps.

Shervington is a registered civil engineer. He is a Mason, and has been active in P.T.A. and Boy Scout work. He and his wife, Wilma, have two sons, Robert, age 13, and Bruce, age 11.

Shervington will report to District IX on May 1 and assume charge of the District effective May 5.

Womack Elected W.A.S.H.O. Head

State Highway Engineer J. C. Womack of California is the new president of the Western Association of State Highway Officials, it was announced May 5 on his return from the association's 40th annual meeting.

Womack moved up from the vice-presidency of the organization, which is composed of the highway departments of 14 western states, including Hawaii and Alaska.

He will serve until the next annual meeting, which will be held in Seattle, Washington, in June, 1962.

Other officers for 1961-62 are W. O. Wright, State Highway Engineer of Nevada, vice-president; and Forrest Cooper, Deputy State Highway Engineer of Oregon, re-elected secretary-treasurer.

The 1961 meeting was held in Las Vegas, Nevada.

$33,812,485 TO CITIES

A record total of $33,812,485 in State gasoline tax revenues has been apportioned to the 372 incorporated cities in California for city street work during the past fiscal year, it has been announced by State Highway Engineer J. C. Womack.

Interchanges

Spacing, Design Must Be Individually Tailored

By W. L. WARREN, Engineer of Design

In laying out a freeway system, the location of interchanges is a problem which, more than any other, must be solved jointly by the State and local jurisdictions involved, because the freeway interchange is where the two systems come together.

> This article was first presented as a paper by the author before the Street and Highway Conference, Institute of Transportation and Traffic Engineering, University of California, held in January at Berkeley.

It is obvious that no trip either begins or ends on a freeway, and the motorist does not care and may not even know which jurisdiction is responsible for any particular choice of road he uses in making a given trip. Since the common objective of both freeways and conventional roads is to provide facilities for traffic, it is necessary to arrive at a satisfactory joint solution where two jurisdictions meet.

The construction of the California Freeway and Expressway System must be superimposed over a vast network of existing city streets and county roads. Certainly the State system will affect the other road systems and the other road systems will affect the design of the State system.

Spacing Important

Such an integrated system of city, county and state facilities depends largely on the proper location and design of interchanges for its success.

It is therefore important that interchanges be spaced at an optimum distance, taking into consideration the needs of the city and county road systems and the free flow and safety of traffic on the freeway. This can only be accomplished through the mutual cooperation of the State, cities and counties involved.

The high degree of cooperation and the helpful attitude of the cities and counties throughout California has made possible the orderly development of the highway construction program. I believe that this is an example of intergovernmental relationship in which we can all take some pride.

With the great Interstate Highway program which the Federal government now has under way, the U.S. Bureau of Public Roads has, of necessity, been a participant in the intergovernmental relationship involved in interchange locations. The cooperation and helpful attitude of the Bureau of Public Roads is something that the Division of Highways may be more aware of than the city or county governments. Representatives of the State and Federal governments are constantly working out the problems of interchange location involving the Federal government with the State, the cities and counties.

Legislative Action

The California Legislature has laid the ground work for a successful road system in California through recognition and understanding of the overall problem. Sound legislation has provided a workable and continuing program. In the enactment of this legislation, recognition has been given to the need for cooperation between the various governmental agencies when freeways are planned.

The Streets and Highways Code states that no city street or county highway may be closed by the construction of a freeway except pursuant to a freeway agreement between the Department of Public Works and the local jurisdiction. This requires full recognition of the local road systems.

It is in this area that complete agreement must be reached as to the location of interchanges and separations, and the necessary relocation of existing and construction of new local roads.

The statutes also provide for recognition of the freeway routes adopted by the California Highway Commission. In essence, the law states that no new city street or new county road may be connected to a freeway without the Commission's consent. In other words, only those local roads in actual existence at the time of freeway route adoption may be considered for connection to the freeway during design.

Connections Requested

Where freeway planning is well ahead of community development, it is often necessary for the city or county involved to request new connections to freeways. This allows for recognition of the community needs after a freeway route is adopted, if a satisfactory showing can be made to the Highway Commission.

These new connections to freeways become interchanges and their location must be consistent with spacing of adjacent interchanges.

The instructions for completing the estimate of cost for the Interstate System in accordance with Section 104(b)5, Title 23, U. S. Code, Highways, states in part:

"It is important that interchanges be located so as to properly discharge and receive traffic from other Interstate and Federal-aid system routes, or major arterial highways or streets. It is equally important that they not be spaced so closely as either to unnecessarily increase the cost of the system or interfere with the free flow and safety of traffic on the Interstate System.

"Interchanges within urban areas should not be spaced closer than an average of two miles, in the suburban sections of urban areas average not closer than four miles, and in rural sections average not closer than eight miles.

"Obviously, however, in consideration of the varying nature of the high-

way, street or road systems with which the Interstate System must connect, the spacings between individual adjacent interchanges must vary considerably. In urban areas the minimum distance between interchanges should not be less than one mile, and in rural areas not less than three miles. Under normal circumstances the increased cost of construction resulting from the development of an interchange should have a net benefit-cost ratio of not less than 1.0."

While interchange spacing less than that outlined is sometimes permitted on the Interstate System, adequate justification must be presented to and approved by the Bureau of Public Roads for each deviation from the minimum spacing mentioned.

Visit By Committee

In 1959 the "Special Freeway Study and Analysis Committee" of the American Association of State Highway Officials visited California. This committee was composed of engineers representing a cross section of the United States, and they said this about interchanges, spacing and location:

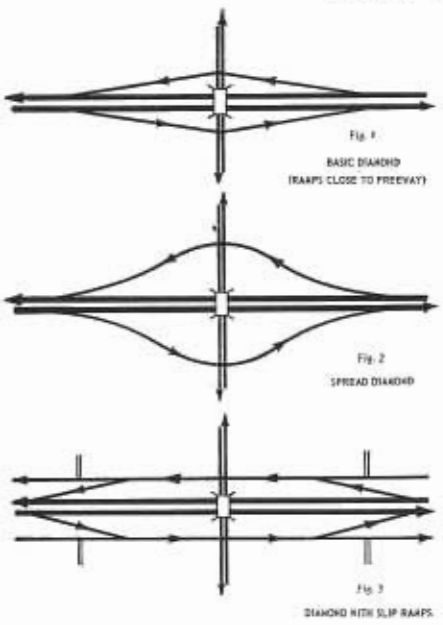
"The committee drew the conclusion that spacing of interchanges is not an initial design criterion but a determination of design to fit traffic needs."

The committee also said:

"A freeway interchange in a rural area should be located where the traffic needs indicate justification

A typical portion of a constructed freeway through a metropolitan area, in this case U.S. 40 through Richmond. To provide adequate traffic service to commercial, industrial and residential areas, many streets must be served to and from the freeway. This illustrates the need for proper planning since the design of one interchange is dependent upon the design and proximity of adjacent interchanges.

PLATE 1



therefor. The resulting spacing may be few or many miles. The same element of justification applied to urban areas must be further supplemented by the need to assure proper circulation of traffic on the arterial and local streets of the city affected by traffic turning to and from the freeway. To do otherwise might concentrate interchange traffic at one or a few locations in such volumes that serious disruption of traffic on both the local streets and the freeway can result.

"Distribution among several streets rather than concentration on one or two would seem to be preferable, provided (1) space is available and conditions are amenable for proper design of the interchange turning roadways, (2) sufficient length is available along the freeway for proper entrances and exits, (3) sufficient length is available along the freeway for installing signing and marking for smooth and proper traffic operation and (4) sufficient length is available for effecting needed transition between freeway and street operation, and accommodating traffic destined for or coming from the freeway on adequate local facilities."

Here we have differing approaches to the problem. The one approach is to establish a minimum spacing of interchanges in rural and urban areas as an initial design criterion while recognizing special cases. The other is to work out interchange spacing as justified independently of land use with the spacing varying perhaps widely.

Purposes Outlined

There are two basic purposes for freeway interchanges: the first, to transfer local traffic to and from the freeway and local road system, and the other for a freeway to freeway type of traffic interchange. In general, no local connections can be permitted to freeway to freeway interchanges due to the conflict that would be introduced.

In urban areas the primary considerations are *traffic operation* and *capacity*. The problem of distribution of freeway traffic to and from the local street network without creating bottlenecks on either the freeway or the local street intersections is difficult and should be the major consideration when interchange location is being determined.

On the other hand, in rural areas where capacity is not a problem, it is only necessary to balance local traffic service against reasonable cost. Numerical warrants for interchanges have not been developed. Warrants therefore are necessarily general and must be based on engineering judgment. It suffices to say that sufficient interchanges are required in rural areas for proper traffic circulation and area development.

To a great extent the location of interchanges is controlled by the location of the freeway in relation to the local road pattern.

For example, the construction of a freeway along an existing highway or expressway almost invariably results in many more interchanges than if the freeway were on entirely new location. Since the freeway absorbs the local service facilities, it must take over the job of this facility as well as serving through traffic.

Conversely, a freeway on an entirely new location does not usually have to consider local traffic service to as great an extent as long as separations are provided at reasonable intervals to allow the existing road pattern to be maintained.

Connection Problem

Where existing towns are by-passed, every effort is made to provide rather direct service to and from the freeway. However, a direct type of connection to the existing highway into a town must sometimes be compromised by the need to connect other local roads at the same interchange, and by the existence of railroads, expensive improvements, or other topographic controls.

In both rural and urban areas the overall community interest must be considered. A traffic interchange or series of traffic interchanges on a freeway through a community may affect the traffic pattern of large contiguous areas. It follows that the location and spacing of interchanges will be affected by the size of the city and the type of area.

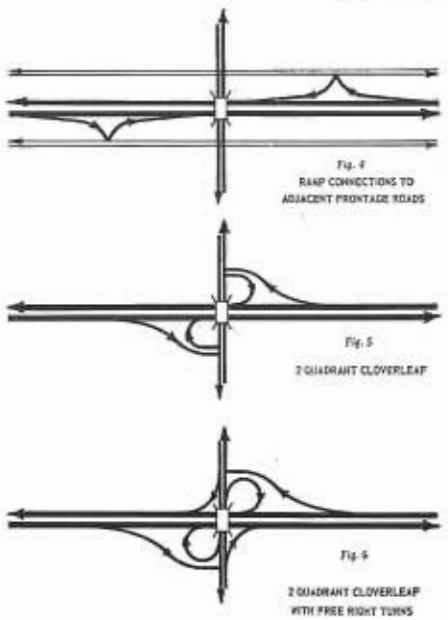
The existence of traffic generators such as large industrial or commercial areas will also affect interchange location and spacing. The core area or business district of a community may require an unusual number of interchanges and ramps to insure the proper operation of traffic on the freeway and adjacent streets.

Master planning of roads and streets must also be considered, to insure that future traffic patterns will be integrated.

Other Factors

There are other factors which, in varying degree, must also be considered, but these factors must not be permitted to lead to heavy expendi-

PLATE 2



tures for freeways which are not properly planned for traffic.

Highway funds must be expended in such a manner as to provide the most service to all traffic without compromising the quality of the service to the main segments of traffic. Since freeway travel is faster, cheaper and safer than travel on conventional highways, it is commensurate with this policy to convert as much conventional highway travel as possible to freeway travel. This is only possible through an adequate number of interchanges.

Although a spot economic analysis may often seem to warrant an interchange, an item of, say, $500,000 in capital outlay must be resolved by experience and judgment in respect to the overall picture in completion or extension of the freeway system.

To summarize:

Planning for interchanges must consider city streets, county roads and State highways as an integrated system and the needs of all these systems must be considered.

Interchanges cannot be so far apart as to concentrate large volumes of traffic at ramps, or so far apart as to entail unreasonable circuitry for off-freeway traffic. Nor can they be spaced so close together as to cause conflict with each other due to lack of weaving and acceleration distances.

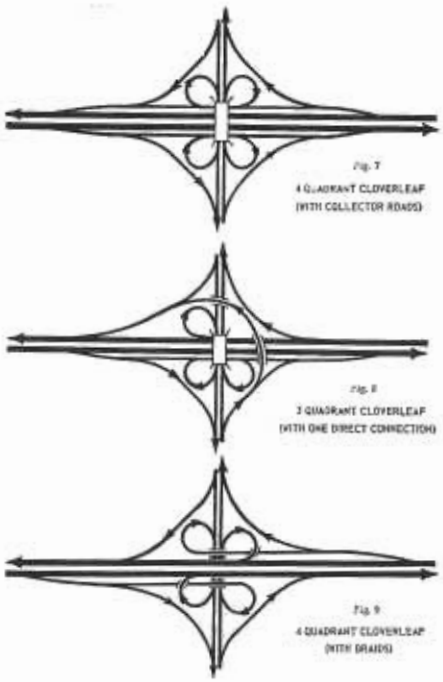
Optimum Spacing Varies

Optimum spacing of interchanges may vary widely under various circumstances. In the interest of construction economy, a minimum number of interchanges is desirable; nevertheless, there are no satisfactory predetermined criteria of spacing.

The principal consideration is traffic service and traffic safety weighed against cost.

Within this broad limit there is a great deal of latitude. The following examples may illustrate this:

From east of Baker to the Nevada State Line, a distance of 48 miles, six interchanges or an average of one in eight miles are planned or constructed. However, on the same route, on the bypass of Baker itself, approximately two miles in length, it is necessary for proper traffic service to provide a direct connection at each end of the



community and an interchange in the middle—or three interchanges in two miles.

On a project just west of Santa Barbara through an area of developing subdivisions, five interchanges are being provided in an 8½ mile project or approximately one every 1¾ miles.

On U.S. 40 between the American River north of Sacramento and Auburn, a distance of 30 miles, 27 interchanges are provided. Individual spacings vary, however, from a minimum of 2,400 feet to a maximum of over two miles.

Between Lodi and Sacramento on U.S. 99, a distance of 25 miles, there are 17 interchanges.

In urban areas such as Los Angeles, the spacing is fairly close. For example, the Hollywood Freeway from the 4 level structure to Vineland Boulevard, a distance of 9½ miles, has 16 interchanges—an average interchange spacing of six-tenths of a mile.

The Bayshore Freeway from near the Bay Bridge in San Francisco to Moffett Field, a length of 36 miles, has 36 interchanges.

Obviously, when all considerations are carefully weighed, the spacing may vary widely from project to project or interchange to interchange.

Types of Interchanges

Like other features of freeways, interchange design has evolved through the years, so that present-day interchanges are sometimes different from those of 10 or 15 years ago.

There are probably few places in the field of engineering where there is such room for originality and free thinking on the part of the designer. There are probably few cases, too, where each element of design is so costly and where each element can produce user saving of such magnitude.

Considerable time is devoted to interchange design in both the District offices and Headquarters office of the Division of Highways. The various designs developed are sometimes displayed like paintings in a gallery. The basis of judging, unlike that used for paintings, must be the more mundane factors of construction costs, right of way costs, adaptability to signing and user benefits.

Traffic Cost Considered

In design, each interchange presents an individual problem, for it must be considered in conjunction with adjacent interchanges, and the project as a whole. The choice of interchange type is dependent on many factors, but primary considerations are traffic and cost. Cost is made up of both construction and right of way costs, and traffic considers not only traffic volumes but also user costs.

The diamond interchange with ramps close to the freeway shown in Figure 1 might properly be considered the most basic interchange type. In one sense, other interchange types are modifications of this design to fit specific conditions.

The tight diamond design is most appropriate when the freeway is either depressed or elevated with the cross road remaining at natural ground. This condition is often found in metropolitan areas where the freeway must be separated from many cross streets.

If the freeway is depressed, good sight distance is provided on both the off-ramps and the cross road. If, however, the freeway is elevated, sight distances are somewhat restricted; and, where prevailing conditions allow, the ramp intersections on the cross road should be moved away from the freeway. Because of prohibitive right of

way costs, many of these tight diamond interchanges have been constructed in large metropolitan areas. These interchanges have satisfactorily handled large traffic volumes when the intersections are signalized and the cross roads have sufficient capacity.

Spread-diamond Type

The spread diamond type of interchange shown in Figure 2 is usually found in rural areas where the freeway is in the vicinity of natural ground and the cross road is raised over the freeway. The ramp intersections on the cross road are moved outward from the freeway to improve sight distance. The distance that these intersections may be moved away from the freeway must often be compromised with consideration to local improvements, right of way costs and the proximity of frontage roads.

The spread diamond interchange would also be appropriate when the freeway is in the vicinity of natural ground and the cross road is depressed. This combination of elevations is seldom resorted to, since it lacks flexibility of stage development on the cross road and is usually expensive.

The diamond type interchange with slip ramps into one-way street patterns is shown in Figure 3. This design is often appropriate when parallel frontage roads are so close to the freeway that additional intersections cannot be provided on the cross road. Sufficient weaving distance must be provided on the frontage road for local and ramp traffic if this type of interchange is to function properly. The condition where slip ramps enter the frontage road at the intersection with a cross street should be avoided since undesirable weaves will occur.

Parallel Frontage Roads

There are many examples where an interchange type with ramps connecting to parallel frontage roads, as shown in Figure 4, may prove appropriate. The ramps provided by this type of design are often referred to as "hook ramps". To minimize this hooked effect, the designer should provide the best standards of alignment feasible, with special emphasis given to the off-ramps. Sufficient deceleration distance should be provided between the loop radius and the off-ramp nose to minimize the tendency to overdrive the curve.

In the general case, this type of interchange results in poor standards of alignment for the ramps and presents additional conflicts for traffic destined to the cross road. Sight distance, however, is usually good, which may account in part for the use of this interchange type in rural areas where the cross road is carried over the freeway and sight distance would be restricted if a tight diamond (Figure 1) were provided. In built-up metropolitan areas, this hook ramp design may be the only feasible type because of high right of way costs and nearby parallel frontage roads.

The two-quadrant cloverleaf design shown in Figure 5 is a type often used in rural areas where the freeway is near natural ground and the cross road is carried over the freeway. This type has the advantage of eliminating the left turning movement of vehicles on the cross road approaching the intersections from the freeway side where sight distance may be restricted. Less right of way is required by this design than by a spread diamond; however, construction costs are usually higher.

When considered in conjunction with adjoining interchanges, this design may provide better weaving distances than would a four-quadrant diamond type. A pattern with loops for the on-ramps is considered preferable to one with loops for the off-ramps since better off-ramp alignment is provided and no left turning movements need be stored on the cross road on the freeway side of the intersections where sight distances may be restrictive.

PLATE 4

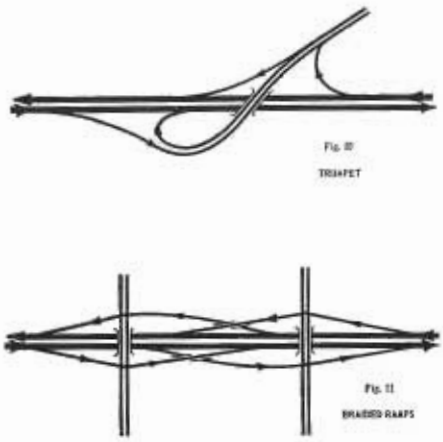


Fig. 10
TRUMPET

Fig. 11
BRAIDED RAMPS

No Weaves Allowed

A further elaboration of the two-quadrant cloverleaf is shown in Figure 6 where free right turns are provided from the cross road. No weaves are involved in this pattern and the only left turns involved are from the off-ramps. When these left turns can be tolerated this design may be preferable to the full four-quadrant cloverleaf shown in Figure 7 since it is less expensive, requires less right of way and has no weaving conflicts.

Quite often when conditions are such as to justify a four-quadrant cloverleaf interchange the ramp traffic is so large that weaves on the freeway are considered objectionable, and collector roads are provided. The ramp noses on the freeway will therefore be located as much as 1000 feet or more from the cross road, and weaving distances between adjoining interchanges may not be adequate.

The two-quadrant cloverleaf with free right turns or the four-quadrant cloverleaf designs may be justified in built-up areas only when traffic volumes are expected to be extremely high, since right of way will be very expensive. In rural areas these types may be provided when the cross road is a major high speed facility.

Further Modification

The interchange type shown in Figures 8 and 9 is further modification of a four-quadrant cloverleaf to accommodate high predicted traffic volumes.

The design with one direct connection shown in Figure 8 might be justified to serve a predicted high peak hour volume from a nearby industrial plant. One of the major advantages resulting from this direct connection would be that the major traffic movement is not involved in any weaving conflict.

Figure 9 shows a design which braids out the weaving conflict between loop ramps. In some cases, this braided plan can be provided at a cost comparable to the four-quadrant cloverleaf with collector roads.

Another interchange type commonly used is the trumpet. This design may be shaped in many ways, one of which is shown in Figure 10. The trumpet may be appropriate when a cross road ends at the freeway or where a direct connection to built-up area is considered justified. In some cases the backward movements shown may not be required.

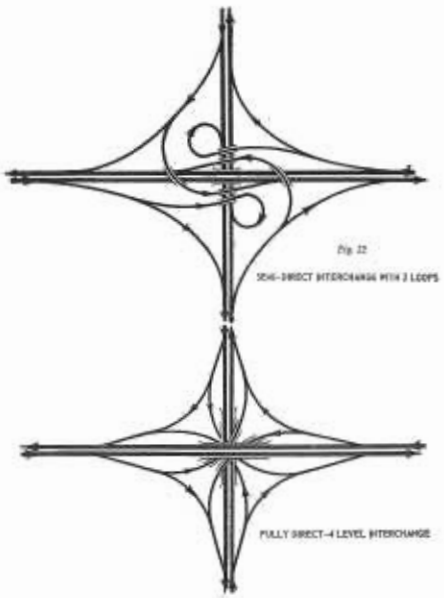
The design shown in Figure 10 has the disadvantage of ending what may be a high speed road on a loop connection. If conditions allow, this may be overcome by reversing the direction of the trumpet and placing the heavier volume on a loop ramp off the freeway where the lower speeds will be anticipated. A further disadvantage to the trumpet is the lack of adaptability if in the future it is deemed necessary to extend the cross road to the opposite side of the freeway.

Braid Method Costly

In the effort to provide satisfactory traffic service, we are often faced with the necessity of interchanging with two cross roads within one-half mile. If sufficient weaving distance cannot be provided between on- and off-ramps, these ramps must be separated by a braid as shown in Figure 11. Since it is obviously expensive to provide braids in this fashion, the designer will always investigate the many possible interchange types and shapes that might be provided to determine if any feasible alternates are available.

Interchange movements must also be provided when two through freeways intersect or where one freeway ends at the intersection with another. The minimum requisite of a freeway to freeway interchange design is that all movements must be free flowing, with no left turns. Several of the local interchanges previously discussed have this qualification. Among these are the four-quadrant cloverleaf and its variout possible modifications (Figures 7, 8 and 9). Other types are the semi-direct with loops shown in Figure 12, and the fully direct four level interchange shown in Figure 13.

The choice of the proper freeway to freeway interchange is often a difficult one. Differences in construction and right of way costs, circuity of travel, aesthetics, capacity, etc. are



significant and considerable engineering judgment is required in weighing these factors one against the other. In metropolitan areas, these interchanges are often further complicated by the necessity to provide local service within the interchange area. Experience has shown that each case is an individual one; an interchange pattern cannot be prototyped.

The four level direct interchange may be appropriate in a large metropolitan area where all movements are anticipated to be very heavily traveled. Interchanges of lesser cost and magnitude are provided with consideration to area, improvements, traffic service, cost, etc.

The diamond interchange is still the workhorse on the team of interchanges. Far from being a substandard facility, it can handle, if properly designed and signalized, very large volumes of traffic.

Delay on Loops

The delay to all cars going around a loop may be 30 seconds or more regardless of what other traffic may or may not be using the cross street. This 30 second delay is about three times the average delay at a traffic signal and more than three times the delay at a rural typical stop sign. In addition, if traffic volumes leaving a freeway at a given interchange are very large, this traffic will cause disrupting of the progressive movement along the city street regardless of whether it comes from a signalized diamond off-ramp or from a loop off-ramp. Conversely, if the volume coming from a loop off-ramp is small enough to be absorbed by the cross street without adding traffic lanes to the cross street, this volume can also be added to the cross street traffic stream by means of a signalized intersection.

At present there are more than 1,000 completed traffic interchanges in operation on the State Freeway System. Apparently State and city or county systems have met in about 1,000 instances. In observing the operation of these interchanges, it appears in general that mutual considerations have been successfully met. More important, it appears that we have profited from experience and the field of knowledge is increasing.

Bids Called for South State Jobs

The State Division of Highways has called for bids on large scale freeway jobs in Los Angeles and Riverside Counties.

The *Los Angeles County* project consists of constructing nine bridges on the future route of the San Diego Freeway between Studebaker Road and Cherry Avenue in and near Long Beach.

A total of $3,700,000 in state highway funds is available for the project.

Bridges will be constructed to carry the future freeway over Studebaker Road, Los Cerritos Channel, Stearns Street, Palo Verde Avenue, Woodruff Avenue, and Bellflower Boulevard.

The *Riverside County* project involves grading and paving to construct 5.6 miles of four-lane freeway on U.S. Highway 60 between Sunnyslope and Orange Street in Riverside.

A total of $5,530,000 in state highway funds is available for the project.

Eleven bridges are included in the project, including structures over the Union Pacific Railroad and the Santa Ana River.

This project will connect with three miles of freeway now under construction on U.S. 60 in Riverside.

Farmlands

Freeway Construction Requires Few Adjustments, Study Shows

A REPORT OF THE LAND ECONOMIC STUDIES SECTION, RIGHT-OF-WAY DEPARTMENT

Summation by BAMFORD FRANKLAND, Headquarters Right-of-Way Agent

A 13.6-MILE segment of Interstate Highway Route 5W in western Yolo County, California, was completed in January, 1960. This new highway, a freeway, was built on new location through an area which is entirely agricultural. The freeway right of way is a minimum of 208 feet wide and required the acquisition of some 438 acres of farmland. Forty-six farms now lie adjacent to the new route. Five of these were severed by the freeway, leaving a remainder on each side; strips of various widths were trimmed from one side of 38 of the farms; and only three of the total were not physically touched by the new route.

Purpose of Study

What are the consequences of freeway construction in such an agricultural area? What are the effects of the acquisition of a 208 foot right of way; of the acquistion of 438 farmable acres; of the severance of a farm; of the acquisition of a strip from the side of a farm; of the physical imposition of a freeway upon an area where none existed before?

The purpose of this study is to investigate these consequences of right of way acquisition and freeway construction, and to provide factual data which may assist in the evaluation of such factors in similar agricultural areas where future freeway may be considered.

Study Area and Freeway

Relatively few miles of freeway are constructed on new alignment through entirely agricultural areas. One such is in western Yolo County

The study area and freeway discussed in this article are shown on the above map by the heavy black line.

between the farm communities of Winters and Madison, in a portion of California's rich Central Valley. It is approximately 68 miles north and east of San Francisco, and 32 miles west of Sacramento. Its main marketing centers are Sacramento and the City of Woodland, which is 12 miles east of the study area. Map One illustrates this orientation.

The farm properties studied lie adjacent to Interstate Highway Route 5W, the western connecting link between Interstate Route 80 (serving the San Francisco Bay Area and points East) and Interstate 5 (U.S. 99W), which serves Northern California. Interstate Route 5W has been constructed entirely on new alignment, about a mile east of old State Highway Route 90, locally known at the Vacaville-Dunnigan Cutoff.

Sufficient right of way to construct an ultimate six-lane, full freeway was acquired. Initially, only two of the ultimate six lanes and two of the eventually needed eight grade separation structures noted below have been constructed. Eleven roads intersect the freeway at approximate one-mile intervals along the 13-mile route. Five of the 11 will interchange traffic with the freeway. Three of the intersecting roads will cross the freeway but will not provide access to it, and while the remaining three roads will neither interchange with nor cross the freeway, they connect to roads which do. Access to and/or across the freeway is now at approximate two-mile intervals.

Character of Area

The Winters-Madison area has been in a state of transition for over 20 years. An adequate water supply, a nearly level farming surface, and improvements in farm equipment have encouraged farm operators to gradually change from dry farming to irrigated row crop farming.

Prior to 1938, the approximate 8,750 acres contained in the ownerships abutting the freeway route were nearly all farmed by their owners to field crops which do not require land leveling. By 1961 over 5,000 acres had been leveled for irrigated row crop cultivation. Almost 3,400 acres are still farmed to field crops but this acreage is decreasing each year. About 350 acres of the choicest soils in the area traditionally have been devoted to fruit and nut orchards.

The basic dry field crops are barley and wheat. Basic row crops are tomatoes, sugar beets and alfalfa, while the orchards produce walnuts, almonds, peaches, apricots and prunes.

Along with the trend toward conversion of land to more intensive farming uses has gone a trend toward absentee ownership. Only 23 percent of the 8,750 acres are still owner-operated.

Study Method

One practical approach to the determination of the consequences of free-

way construction in an agricultural area is to catalogue and analyze both the *changes* which have occurred in adjacent properties and the *adjustments* made by their owners or operators subsequent to the acquisition of right of way. Either the changes themselves, or the lack of changes and adjustments, would be indicative of and could lead to a conclusion of freeway effects. This is the approach used in this instance, and it necessarily presumes that farm operators will attempt to adjust quickly to the new conditions imposed by a freeway in order to continue to operate their farmsteads profitably.

Five major alternatives are available to the farmer in adjusting to any freeway-induced changes in his operations. He can:

1. As an owner, sell or lease all or portions of his land, or buy or lease additional units.
2. As a tenant, cease operating; sublease all or a portion of his leasehold; or change his lease terms as soon as possible.
3. Change his farming practices and/or the crops raised.
4. Change the farm improvements.
5. Make changes in his equipment inventory.

Each farm in the study area was carefully analyzed in the light of the above alternatives. Additionally, an attempt was made to establish what portion of the monies paid for rights of way had been reinvested in the various farms. It was felt the reinvestment of such payments in the farms involved would clearly provide another helpful insight into freeway effect.

In carrying out the above approach, the five major change factors were investigated over a four year period starting in April, 1957, the date of the first right of way acquisition in the area, and January, 1960, one year—or one full crop cycle—after completion of freeway construction. Within this framework separate analyses were made of the three basic farm types, i.e., *orchards*, *row crops*, and *field crops*, to evaluate differing effects, if any, attributable to the freeway.

Additionally, within these three subcategories, farms which were *trimmed*, those which were *severed*, and those which were *not touched* by acquisition, were also separately examined. (A trimmed farm may be defined as one where right of way was acquired along its boundary leaving the remainder as one entity; a severed farm is one in which right of way acquisition has left a remainder on each side of the freeway.)

This aerial view showing the freeway under construction illustrates the intensive cultivation practiced in the area.

Map Two shows the 46 property ownerships in the study area as they existed in 1957 prior to right of way acquisition for Interstate Route 5W. Also, represented on the map are internal field divisions and the locations of farm residences. Map 2-A shows the same properties and their relationship to the new freeway.

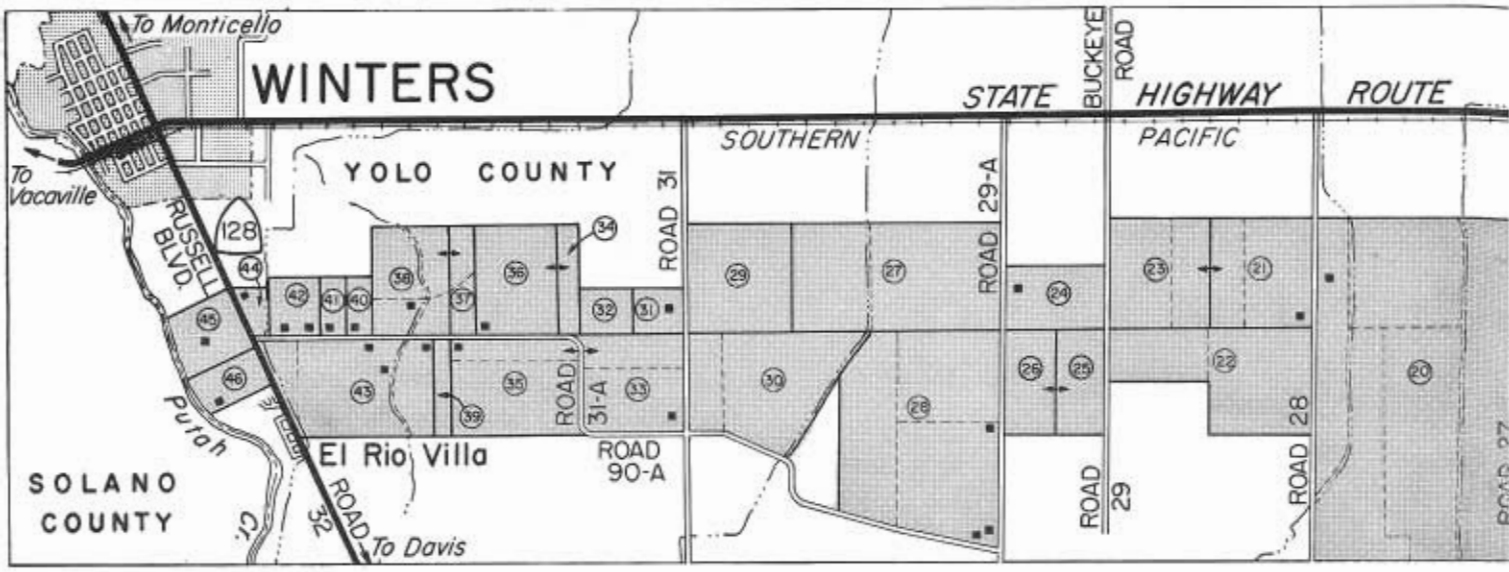
Ownerships

A tabulation of farm ownerships in the study area revealed a wide range of farm sizes as well as a wide range of amounts of farmland acquired for rights of way. The smallest operating farm (an orchard) in the area contained slightly over ten acres as opposed to the two largest individual holdings of approximately 1,200 acres each.

Right of way was acquired in amounts ranging between 0.04 acre and 38.64 acres from 43 of the 46 adjacent ownerships. Only three parcels were not touched in some way by the freeway construction. Five ownerships were severed and the remaining 38 were trimmed by widely varying amounts.

There are several courses of possible adjustment which an owner might take as a result of the reduction in size or severance of his property. For one, he can change, in some manner, the size of his farming operation. He might add to his holding—as replacement for the land required for right of way—or he might dispose of all or portions of his ownership to eliminate difficult farming operations. Either of these alternatives could be accomplished by means of purchase, sale or lease.

Four of the subject properties have been sold during the four year study period—at prices which are equivalent to or in excess of the going acreage rate in the area. Three of the sales were normal transactions which would have occurred in the absence of a freeway. One—an 80 acre parcel from which



This map shows the outlines of study area properties, improvement locations and field division

0.08 acre had been acquired for the purpose of improving the junction of two county roads—sold when its owner retired. Another—a part-time farm—sold following the death of its owner. The third was another 80 acre farm from which slightly over two acres were acquired. This farm has actually sold twice during the study period and is now again listed for sale. Each sale has been to a speculative purchaser who did not himself intend to farm the property, and each sale and the listing have reflected an increase in value over the base price in the area.

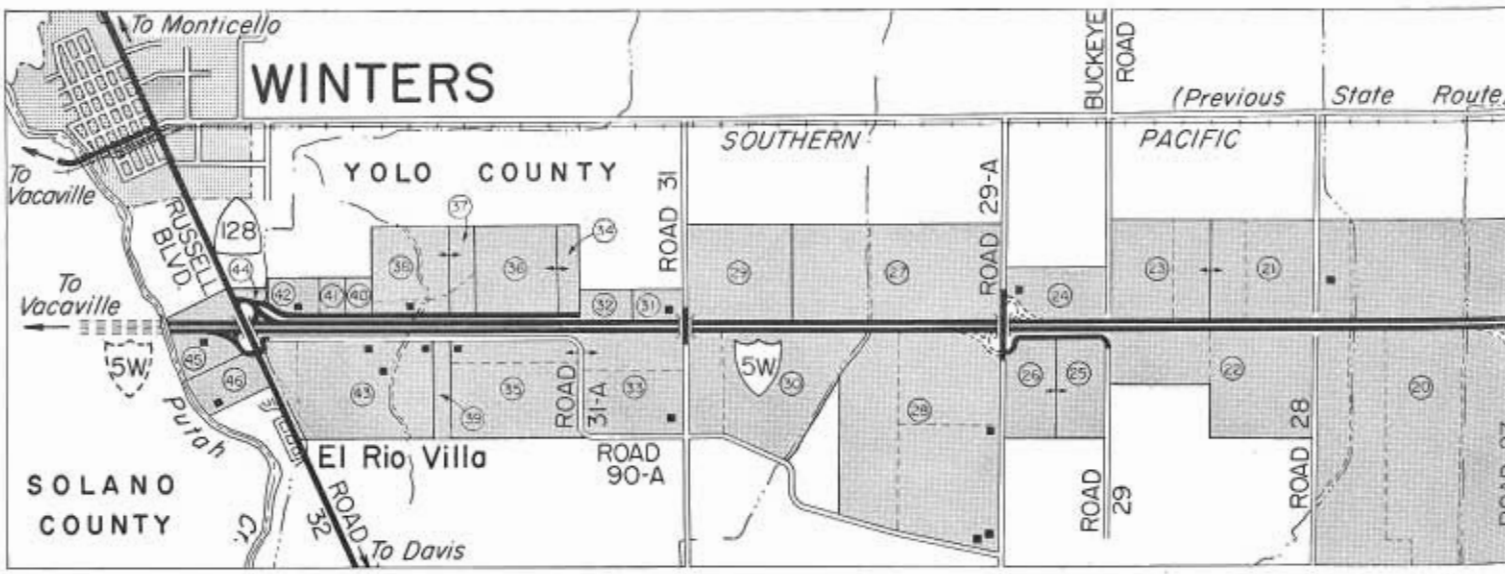
The fourth sale was of the smallest parcel affected by the freeway. An interchange ramp system required the acquisition of nearly nine of its ten and one-half acres. After its sale (for a price 50 percent in excess of its agricultural value) a service station and soft drink stand were constructed on the small remainder.

No other actions affecting farm sizes have been taken by owners in the study area. *None have sold a portion of their farms; none have leased all or any portion of their farms* (except in one instance where an owner died and his heirs leased the property rather than sell it) *and none have purchased or leased any replacement land.*

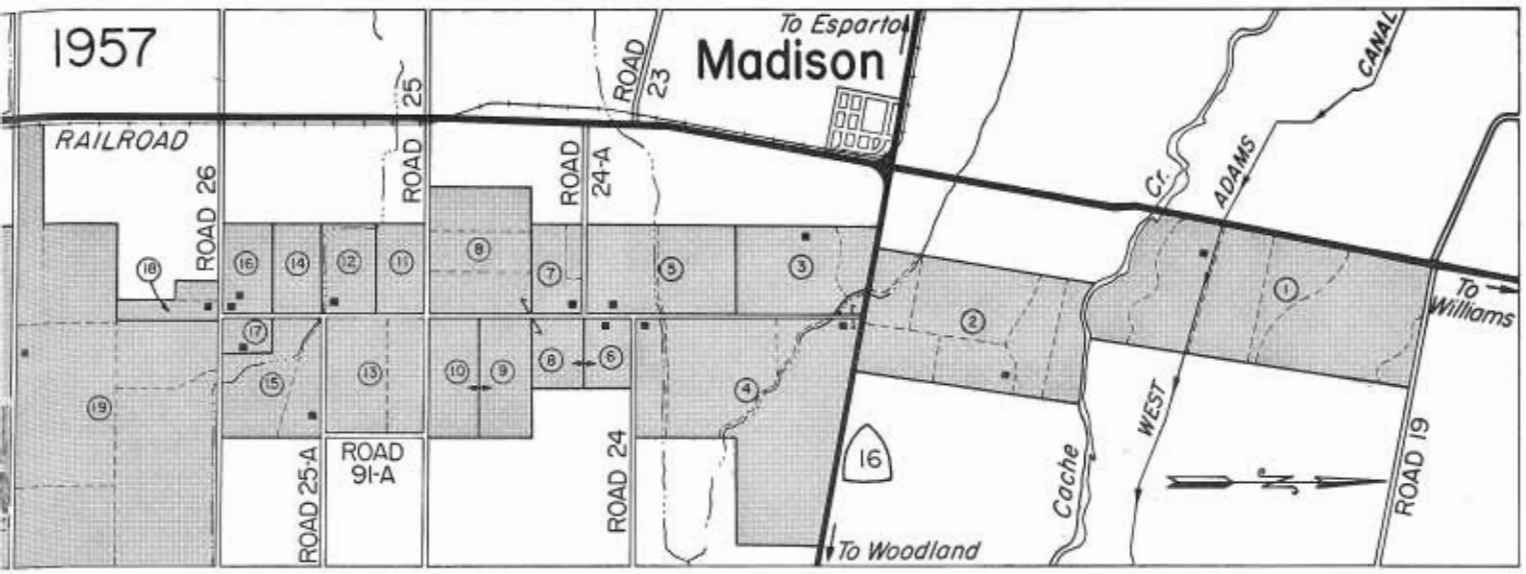
Leases and Lease Terms

The study of ownership changes reveals attitudes of owners toward the newly constructed freeway. Only 20 of the 46 properties were, however, owner operated. The remaining 26 properties are operated by lessees (tenants).

Three basic adjustments by tenants to adverse forces are possible: An operator might give up his lease entirely; he might revise his leased unit arrangement by sub-leasing all or portions of the leasehold or; he might



This map shows the location and ultimate construction of Interstate Route 5W near the towns of Winters and Madi



s before freeway construction. The arrows connect separate properties which are farmed together.

seek relief through a change in the terms of his lease.

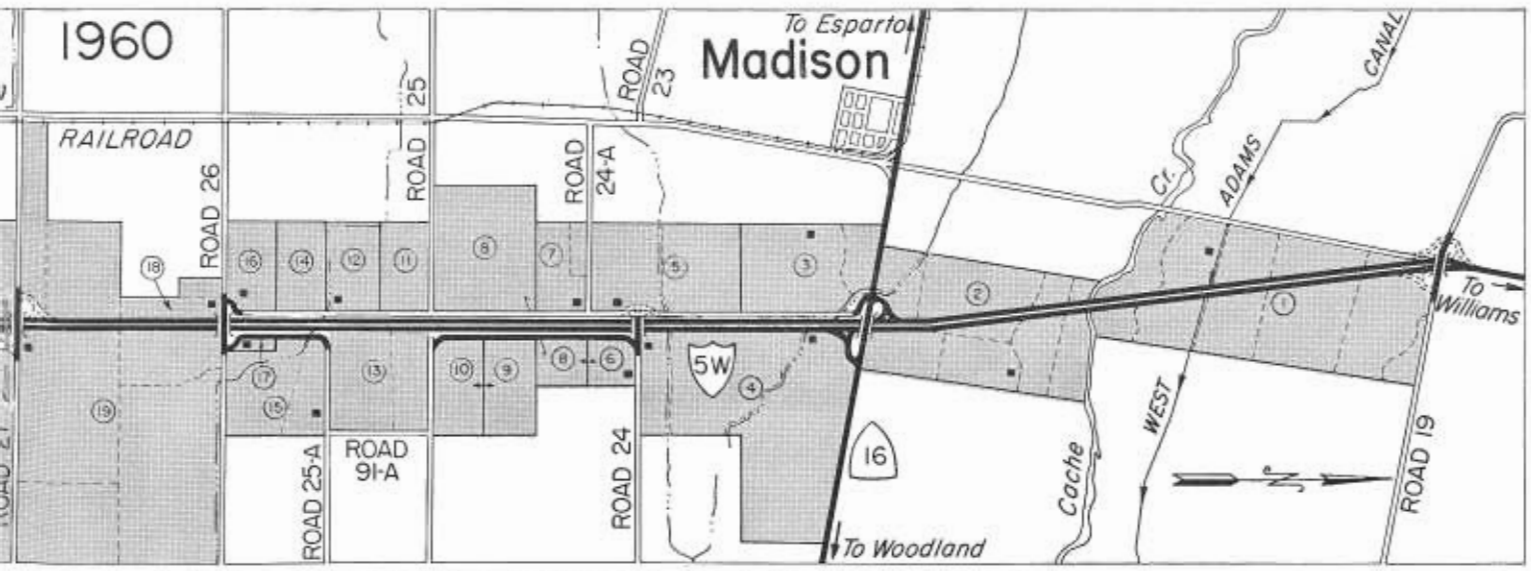
The first mentioned reaction (giving up the lease) is highly unlikely since it would probably affect the capability of the tenant to lease other land in the area. No operators have taken this course of action. Only one tenant has resorted to the second alternative. In this case the operator sub-leased two small ownerships containing about 54 acres to another nearby operator, after the parcels had been severed from the larger portion of the operating unit.

With respect to lease terms, it is apparent in this area that the growing trend toward tenant operation of farm units has strongly increased the competition among tenants for available land. For this reason it would seem more probable that any increase in difficulty of farming might be first compensated for by a change in lease terms if possible, and only secondly by a change of operator.

Ten of the 26 leases in the area have come up for renewal during the study period. Three of these covered farms which had been severed by the freeway route and seven were leased farms which had been trimmed. *All ten leases were renewed by the same operators and no changes were made in lease terms.*

Crop Changes

Perhaps the simplest adjustments an owner or operator might make are in his farming practices or crops raised. Two alternatives were considered. The one major alternative available is for the farmer to compensate for increased farming difficulties by planting crops which require less care. This adjustment was not made by any of the farmers in the study area. *There have been crop changes but in each of the six cases noted, the changes have been to crops requiring more rather than*



son. Interchange structures have been completed only at the freeway intersections with State Sign Routes 128 and 16.

less care. The changes, moreover, were all made in accord with the trend toward more intensive cultural practices previously noted and as part of long range land conversion plans. *In each case land previously devoted to field or row crops was upgraded for row crop or orchard use.*

The minor alternative considered was that a farmer might combine some of his fields to enable reduction of the number of separate cropping operatings performed. The 46 ownerships in the study area had been divided into 85 fields by their owners or operators. These divisions (before and after freeway construction) are noted on Maps 2 and 2-A.

Freeway construction induced only one instance of field realignment; a unit made up of three 80 acre fields has been combined into one 240 acre field. The combination did not involve any change in the basic crops planted but was accomplished by an alteration in the crop rotation cycle in two of the fields to bring all three into the same rotational phase.

Farm Improvements

Changes in farm equipment inventories and adjustments in or additions to farm improvements are other elements which might be expected to reveal the effects of freeway construction. Has it been necessary for owners or operators to buy additional equipment as a result of freeway construction or; has the location of the freeway or the amount of land required for right of way caused some existing equipment to become obsolete? Has it been necessary for owners or operators to construct additional improvements as a result of the freeway location or; has it been necessary to change the use of existing improvements to meet new conditions?

First, in the area of equipment inventories: *none of the owners or operators of trimmed units have purchased any additional equipment since the date of first right of way acquisition and all have continued to use their existing equipment in the same manner as before. Only two operators of severed units have made any new equipment purchases.* Each has purchased a trailer for the purpose of carrying tracked equipment over the freeway to a severed unit. These represent an investment of approximately $2,000 each. None of the owners or operators of other severed units have bought any new equipment. All continue to use existing equipment as in the case of owners of trimmed units.

Farm improvement were found on only 28 of the 46 farms in the study area. These were generally limited to residences and outbuildings erected during the period when the owner-operation of individual farm units was predominant. Only 19 owners were still in residence on their farms, some as part-time farmers with other places of employment and others as owners who had leased their farms but still lived on the farmstead. There were extensive facilities for prolonged crop storage on only one of the subject farms.

Replacement of improvements which fell within the right of way area was negligible. Five owner-occupied and six tenant-occupied residences, seven barns, four sheds and four garages lay in the path of the freeway. These were purchased by the state at a cost of $123,000. Following this acquisition, two of the tenant-occupied homes and a barn were moved to remaining property, and two new homes were constructed on other remainders. Approximately $30,000 has been expended by the three owners for the above noted moving or replacement costs and the remaining owners who did not make replacement indicated in interviews that the monies paid for improvements had been placed in savings. *There have been no additional improvements constructed on any of the farms; no changes in use of existing improvements; and no adjustments made as a result of freeway construction.*

Compensation

A total of nearly $625,000 was paid to the 43 affected owners from whom rights of way were acquired. This total included $316,000 for land; $123,000 in payments for improvements; and $186,000 as compensation either for curative work to be done by the owner, or for appraised reductions in value of remaining properties. The individual payments ranged from a low of $45 to a high of $97,500.

No owners were found who had invested their land payments in substitute lands. Interviews with the recipients and field estimates established that of the $309,000 paid for improvements and damages only 24 percent was reinvested in the subject properties. Overall, about 88 percent of the total $625,000 was actually placed in savings.

1. Investigation and analysis in this instance has indicated that owners and operators have found it necessary to make only minimal changes and adjustments as a result of right of way acquisition and freeway construction in the agricultural area studied.
2. It was early premised that the degree of impact of acquisition and construction would be reflected in the frequency and extent of changes to the original farmstead, following the reasoning that operators would attempt to quickly adjust to any new conditions imposed by the freeway if production and efficiency were significantly impaired. Since such action has been negligible, it follows that the impact of the new freeway in this instance has been negligible as well.
3. In the areas of farm ownership and lease operator–lease term change, the impact has been particularly slight. The buying and selling of farms, and the exchanging or sell- of portions of farms to minimize operational difficulties (actions logically premised if freeway construction were significantly disruptive) are not at all in evidence in the study area. Neither do the lease changes which have occurred appear to indicate other than minimum effect.
4. The analysis of the disposition of monies paid to farmers; of the additional equipment purchased; and the replacement of improvements has also failed to reveal evidence of particularly significant freeway-induced adjustments.
5. It is further apparent that freeway construction has not necessitated any change in the basic crop pattern of the area, nor has it interrupted the normal trend toward more intensive farming practices.

New 17-Mile Road

Los Banos-Turlock F.A.S. Project Opened

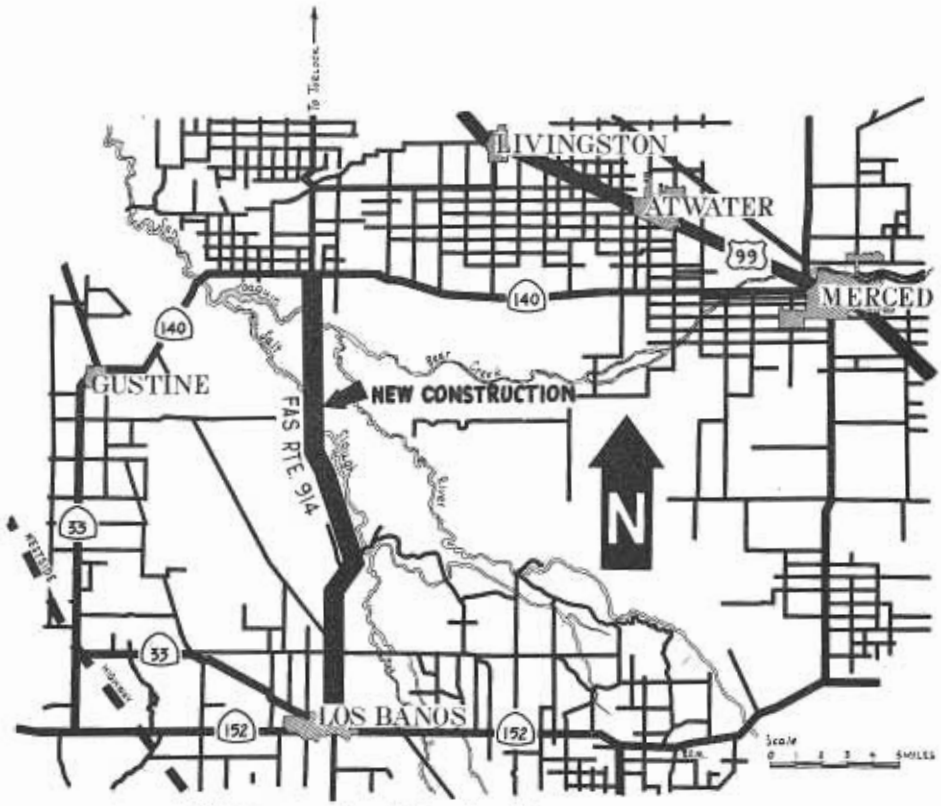
By RAY J. GEIMER, Assistant City and County Projects Engineer, District X

DELINEATED on California Highway Planning Maps since the advent of the Federal-Aid Secondary Road Program following World War II was a dashed line indicating an unconstructed road as a portion of FAS Route 914 running due north from the City of Los Banos in Merced County.

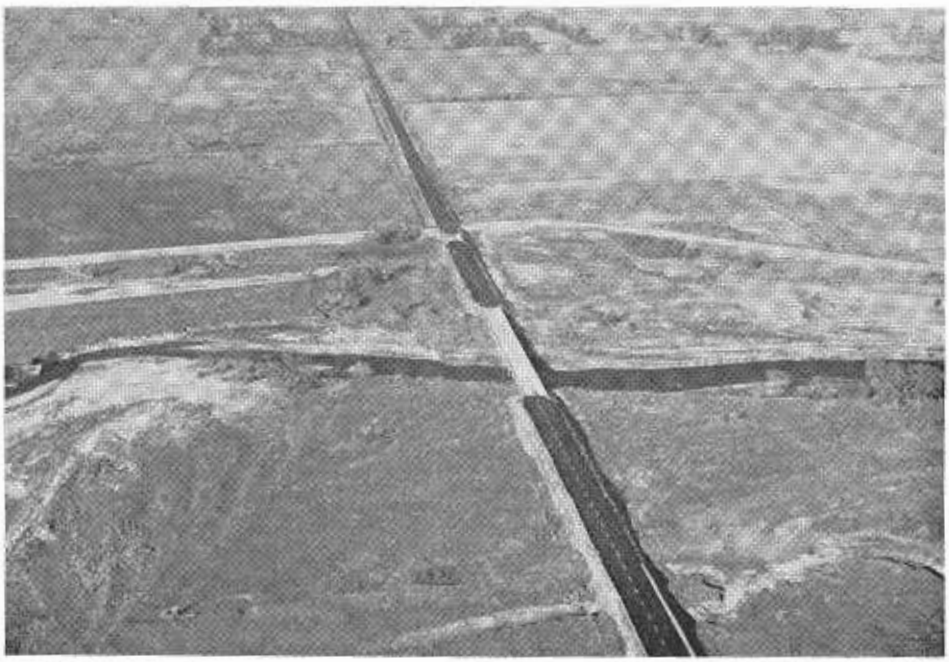
Perusing a road map, it is quite apparent that construction of this segment of FAS Route 914, will afford a large savings in distance and travel time to the highway user traveling between the Cities of Los Banos and Turlock.

However, when one views the area on the ground, it can be readily understood why this portion of the route remained unconstructed for so many years. The project bisects a large area of central Merced County comprising approximately two hundred square miles which has remained in its natural state. The virgin land is devoted generally to grazing for livestock and numerous duck clubs in the flooded lowlands.

During heavy winter rains and the spring runoffs, flooding occurred over large areas adjacent to the San Joaquin River. In order to attain an all-year usable facility, it was necessary to invest a large sum of money to obtain a road built to adequate standards.



The above map shows the location of the new 17-mile highway.



This bridge across the San Joaquin River is on the new Los Banos-Turlock Road constructed under the F.A.S. program in Merced County.

Benefits Recognized

Actively promoting the proposed project were the late Wm. A. McCanless, former Road Commissioner, and Supervisors Harry P. Schmidt and Emory O'Banion. Recognizing the desirability and obvious benefits of the project, the Board of Supervisors of Merced County, in 1956, indicated their intention of budgeting all available FAS and State Matching allocations, as they became available, to complete the construction for the full length, 17.4 miles, between Los Banos and State Highway Route 122.

In cooperation with the State Reclamation Board and the State Depart-

A northward view of the new Los Banos-Turlock Road showing the Santa Fe Canal crossing in the foreground.

ment of Water Resources, the bridges across the San Joaquin River were designed to accommodate the plan of the Lower San Joaquin Flood Control Project.

During 1959, the northerly nine miles were completed with the exception of the surfacing. Included in this contract were three reinforced concrete bridges totaling 565 feet in length and ten reinforced concrete box culverts.

South Portion Completed

During 1960, the southerly eight miles were completed with the exception of the surfacing. The contractor on both of the above contracts was M. J. Ruddy & Son.

Recently completed was a contract for the surfacing of the complete 17 miles of road. The contractor was Baldwin Contracting Company.

The estimated total final cost of all three contracts, including construction engineering, will be approximately $1,346,000, financed with FAS funds in the amount of $765,000; State funds in the amount of $464,000; and County funds in the amount of $117,000.

Completion of this direct connection between the City of Los Banos and the City of Turlock will save highway users, over a period of twenty years, an estimated 44 million vehicle miles, having a value of $4,000,000. In addition, this high-type road will contribute toward the development of a higher land use through the area traversed.

Engineering of the projects is a good example of the fine cooperation existing between the State Division of Highways, the U.S. Bureau of Public Roads, and the Merced County Road Department under the Federal-Aid Secondary Road Program in California.

Preliminary engineering was done almost entirely by personnel of the County Road Department. The projects were advertised and administered as State highway contracts.

Construction engineering was performed by both State and County personnel. Resident Engineer for the first contract was C. F. Roderick. G. T. Guy was Resident Engineer for the second and third contracts.

New Traffic Record On Dumbarton Bridge

The average daily traffic across the Dumbarton Bridge reached an all-time high during March of 7,007 vehicles. This is a 21 percent rise above the March, 1960, average daily traffic of 5,790 vehicles. The San Mateo-Hayward Bridge also broke a previous record. A new high point for a single day's traffic was established on Easter Sunday, April 2, 1961, with a total of 14,715 vehicles. The previous high record was made on Easter Sunday, April 17, with a total of 14,592 vehicles.

Archaeology

State Agencies Cooperate to Save Valuable Midden Sites

THE STORY of past ages of man in California is being uncovered and the relics of ancient cultures are being preserved as a byproduct of the state's big highway program.

This is being accomplished through the cooperation of Federal and State agencies carrying out what the Bureau of Public Roads defines as a national policy to preserve or salvage ruins, sites, artifacts, fossils or other objects of antiquity.

Financing from Federal funds was authorized by the Federal-aid Highway and Revenue Act of 1956 which provides that funds may be authorized to the extent approved as necessary by the highway department of any state for archaeological and paleontological salvage. In some cases, only State funds are involved.

Recognizing the value of this salvage, the Division of Highways was quick to cooperate, as was the Division of Beaches and Parks. A four-phase program for the actual preservation and salvage work was instituted, outlined in a letter from the State Highway Engineer to the various Districts in March, 1957. These four phases are:

1. Coordination, which means, chiefly, keeping Beaches and Parks informed of the road program so that a determination can be made as to the existence of any archaeological sites or objects which will be disturbed by highway construction.
2. Surveys by archaeologists to determine exact location of archaeological sites in the path of highway construction.
3. The actual excavation and salvage of worthwhile historical objects.
4. The packing and removal of the salvaged objects from the site.

The Division of Highways' participation was limited to Phases 1 and 3. The Districts provide all available data to the Division of Beaches and Parks, and, after a survey by Beaches and Parks to provide an estimate of cost, an interagency agreement is executed providing for Highways to furnish the necessary funds for the actual excavation and salvage of worthwhile objects.

Since archaeological salvage is a very specialized procedure requiring special skills and techniques, Beaches and Parks which does not have the manpower available, arranged for other agencies, such as the University of California Archaeology Survey and the Central California Archaeological Foundation to supply the necessary skilled workers from among their advanced students.

Three projects have been very satisfactorily handled in this manner: One in Santa Barbara County near Goleta, one in San Diego County near Carlsbad, and one in Sacramento County near Folsom.

The accompanying account describes the San Diego County project:

By CLAUDE N. WARREN, ELIZABETH VON TILL WARREN, and ERNEST CHANDONET, University of California, Los Angeles

The large scale highway construction being undertaken in California is creating a problem for archaeologists working in the state, for the resultant destruction of archaeological sites is a growing concern. Along existing roads, it is not uncommon to see dark patches of midden, marking the camping places and villages of prehistoric inhabitants of that area. The new freeways, of larger size and designed so that a greater amount of earth movement is necessary in their construction, will undoubtedly cross many more archaeological sites than did the roads constructed in the past. This destruction of sites, however, does not mean the loss of the scientific data they contain, because of the cooperative program developed by government agencies.

The first step toward an active program of highway salvage archaeology in southern California was initiated in June 1959. This initial step, an archaeological survey of the right-of-way for the proposed new U.S. Highway 101, between Carlsbad and the northern city limits of San Diego, resulted in a contract between the University of California Archaeological Survey, Los Angeles, and the State Division of Beaches and Parks for the salvage of the archaeological remains of two sites on Batiquitos Lagoon. A second survey of the U.S. 101 right-of-way in Santa Barbara County in the summer of 1959 resulted in a contract for the immediate salvage of the archaeological remains of two sites near Goleta.

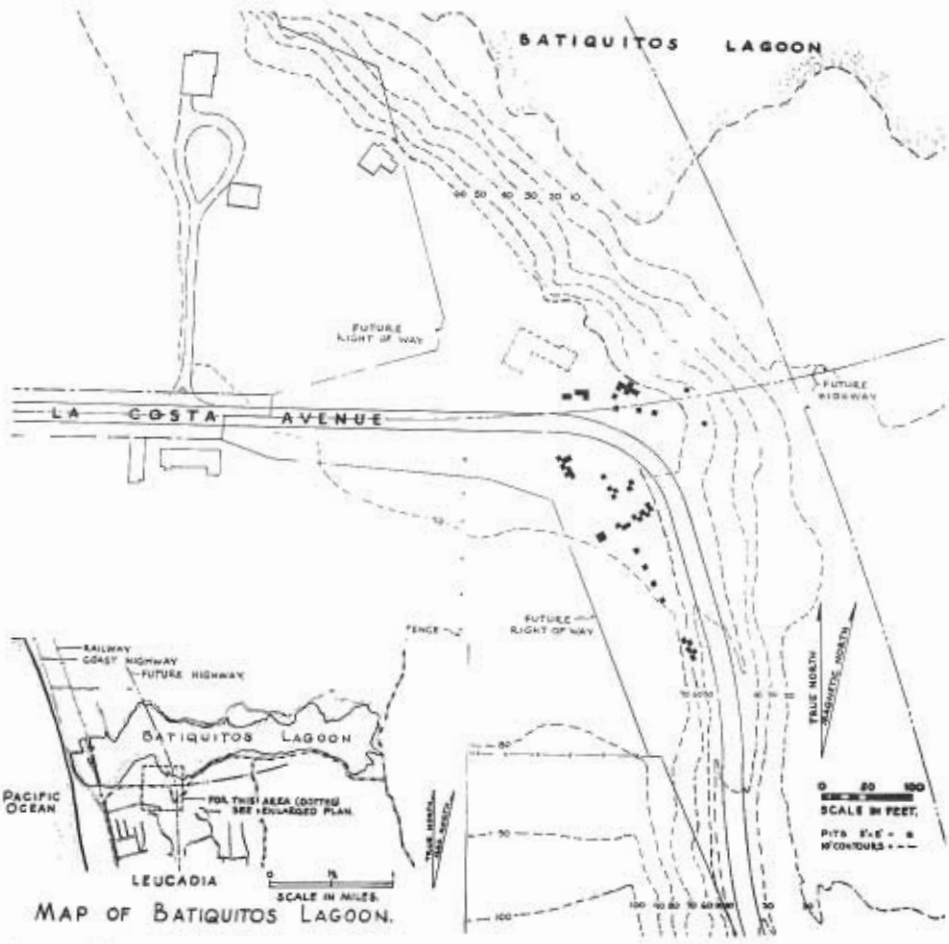
Salvage excavations in San Diego County were begun in August and September 1960, under the direction of Claude N. Warren and Robert H. Crabtree. The operations have not yet been completed and further work is planned for the near future. This report is presented to illustrate how important remains of the prehistoric peoples of southern California are being recovered.

Method Described

In surveying rights-of-way for archaeological remains, the archaeologists, who usually work in pairs, walk the length of the right-of-way in search of areas where there are indications of prehistoric habitation. Such sites are recognizable by the presence of midden, a dark colored soil resulting from the high organic content of decomposed food remains and refuse. In coastal areas in California, such archaeological sites often contain large quantities of shells discarded by the prehistoric peoples after eating shellfish. Also common throughout the state are areas where stone tools and broken rock are found on the surface of the sites as indicators of previous habitation.

Once the site has been located, the archaeologist collects from the surface

Looking south across Batiquitos Lagoon toward Leucadia. The archaeological sites are located near the oblong reservoir in the raised rectangular area (center foreground) and in the vicinity of the looped driveway and rectangle of trees (middleground).



A map of the excavation area near Batiquitos Lagoon. The individual excavation areas are indicated by the solid black squares and rectangles.

all the artifacts (tools and implements) left by the former inhabitants and notes any features such as remains of hearths or structures. Study of these remains often is sufficient to indicate whether or not excavation of the site would yield enough information to make a salvage contract worthwhile. If, after studying the surface collection, the archaeologist is still uncertain about the importance of the site, test excavations are undertaken. Test excavations are generally limited to a small number of pits, 5 feet square, which vary in depth with that of the deposit. Such excavations tell the archaeologists how deep the deposit is, give him a rough estimate of how many artifacts are to be found per cubic yard, and how difficult the actual digging may be.

On the basis of the information collected in these surveys and test excavations, a contract proposal is submitted to the Division of Beaches and Parks, which functions as the coordinating agency between the Division of Highways and the archaeological agency. The expenses for salvage excavations are paid out of highway funds, and by the archaeological agency undertaking the excavation. Generally, the expenses for labor and replacement of equipment are paid by highway funds, while the archaeological agency supplies all equipment, transportation, and publication costs.

Cultural Affiliation of Sites

During the archaeological reconnaissance of the highway right-of-way between Carlsbad and San Diego, two sites worthy of salvage excavation were discovered on the right-of-way. These sites, designated SDi-211 and SDi-603, are located on the margins of Batiquitos Lagoon near Leucadia, California.

SDi-211 is a large site extending one-quarter of a mile along the cliff on the north side of the lagoon. An area approximately 250 feet by 100 feet on the east end of the site will be destroyed by the road cut proposed for the new freeway. The midden in this portion of the site is poorly developed, light brown in color and contains relatively few shells. Artifacts, however, were observed in relatively large numbers on the sur-

face and limited excavations yielded slightly over 200, as well as several features, consisting of broken rocks and artifacts placed together in small piles or cairns.

Second Midden

Site SDi-603, located on the south side of Batiquitos Lagoon is less extensive in area than SDi-211, but has a more developed midden containing large quantities of shell, rock, and organic materials. An existing street, La Costa Avenue had already cut through a portion of the site, exposing midden deposit of 3½ to 4 feet deep. A burial exposed by erosion in the cut was recovered by the San Diego Museum of Man prior to the start of salvage operations. Two carbon samples, one below and one above the burial, giving dates of 7300 ± 200 and 3900 ± 200 years ago, respectively, were assayed by Scripps Institution of Oceanography, La Jolla. Rather extensive excavations undertaken at site SDi-603 during the salvage work, have yielded about 400 artifacts and 14 features similar to those at SDi-211. Unfortunately, no more burials were recovered. More excavations are planned for this site, and it is hoped that burials as well as more of the cultural material of the early inhabitants will be found.

On the basis of the artifacts recovered from thes sites, the rock features and the carbon-14 dates, site SDi-211 and the lower levels of site SDi-603 are judged to belong to an ancient culture termed "La Jolla" because it was first discovered near La Jolla, California. The upper levels at SDi-603 contained potsherds (fragments of broken pots) which indicated that people of a later culture, called "San Luis Rey" by the archaeologists, occupied the site after the time of the La Jolla people.

The people of the La Jolla culture made their living by gathering seeds and roots from the nearby mesas and shellfish from the deep cut bays that characterized the San Diego coast line some 4000 to 7000 years ago. Batiquitos Lagoon, now a salt marsh no longer capable of supporting shellfish, was then a typical example of such a bay. At a time during the last glaciation, the sea level was considerably lower than at present, since great

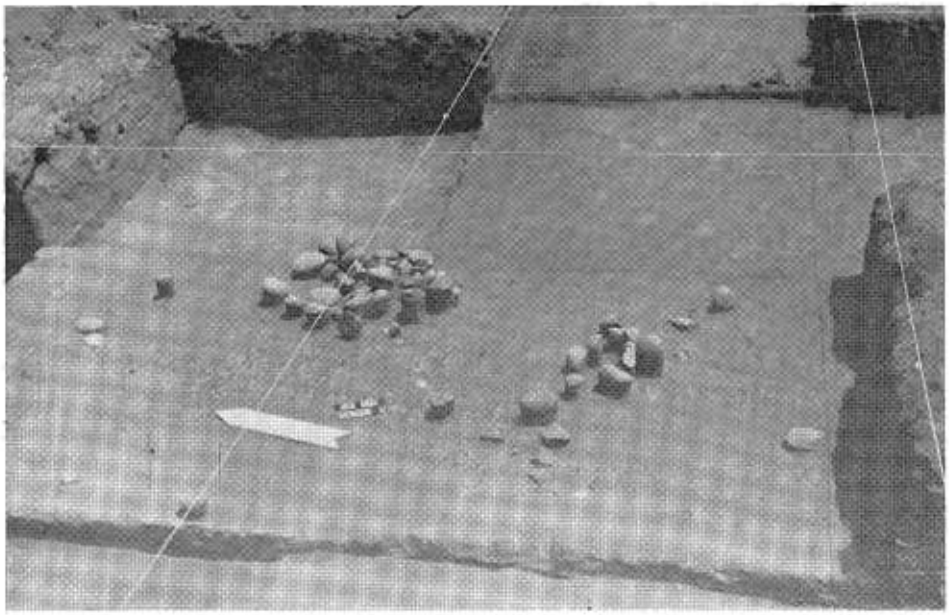
A shell midden exposed by a road cut. The dark soil and shellfish remains of such middens are indications of former human occupation of the area.

Excavating Site SDi-603. The five-foot-square pits used as excavation units are visible to the left of the dirt piles.

quantities of water were then locked in the huge glaciers of the northern hemisphere. During this period of lowered sea level, the streams and rivers flowing westward to the ocean in San Diego County cut deep canyons in the relatively soft deposits of the coastal plain. Some of these canyons were as much as 100 feet deeper than they are at present.

Valleys Are Flooded

With the melting of the glacier, the water returned to the ocean and the sea level rose, flooding the deep coastal valleys and creating deep, narrow bays. These bays supported large



Stone features at Site SDi-211. The round pile of rocks is probably an ancient hearth, while the smaller, irregular scattering to the right may represent waste material left by an aborigine after making tools.

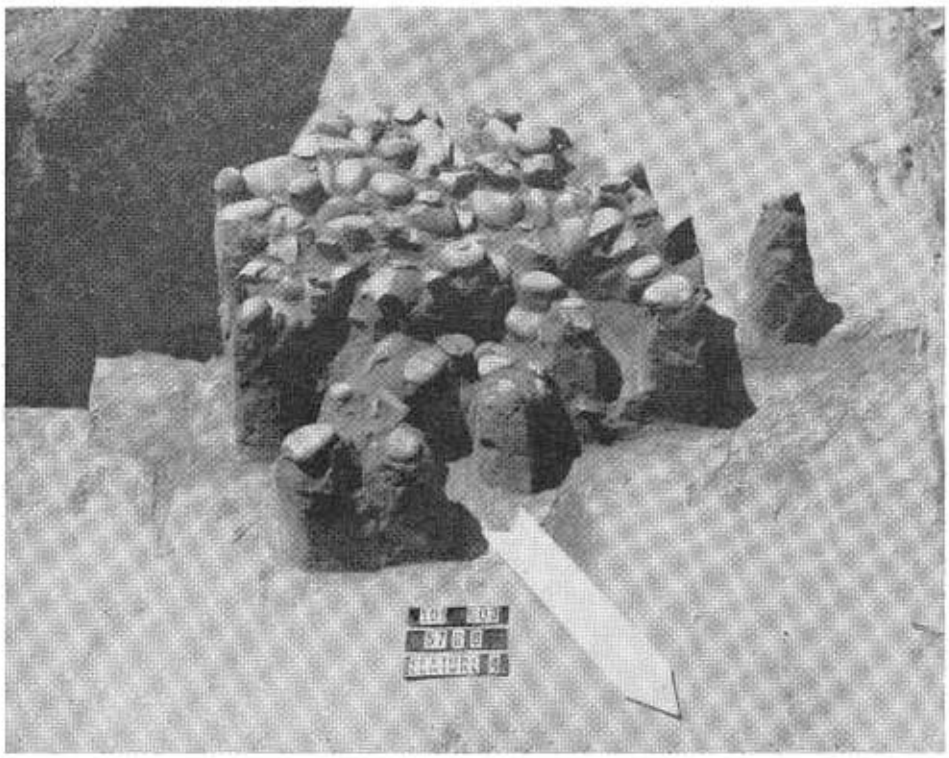
quantities of shellfish and it is thought that it was during this time that the La Jolla people came to the coast. Where they came from we do not know, but they appear not to have been adapted to a maritime way of life, since they did not take full advantage of the supply of food offered by the ocean and bays. For example, no specialized fishing gear such as the shellfish hooks of later, sea-oriented people, or harpoons for the hunting of sea mammals, have been discovered in La Jolla sites. The tools found, illustrated in the accompanying photographs are the exceedingly crude implements used for scraping, pounding and grinding. Most common are the mano and metates used for grinding of seeds. Rarely, a dart of spear point is found, and correspondingly scarce are the bones of mammals hunted with such weapons. Fish bones occur, but not in the quantity that might be expected in the remains of a people living near the sea. The only sea food remains that occur in quantity are the shellfish from the shallow waters along the shore.

These archaeological remains suggest that the economy of these people was adapted to the collecting of wild plants, with occasional hunting of small land mammals. This economic pattern is more characteristic of an inland group than of a people living beside the ocean. It is thought, therefore, that the La Jolla people migrated to the coast from the desert region. This theory is further supported by the fact that the deserts were becoming increasingly dry as the glaciers melted. The great desert lakes evaporated, and the region could no longer support the population of plants and animals (man included) that it formerly had. This dessication of the desert, as far as we know, took place at about the same time that the La Jolla people first appeared on the coast.

Lacked Techniques

Upon reaching the shore of the ocean, the La Jolla people, with their gathering economy, did not have the techniques or the technology for hunting sea mammals or taking fish in great quantities. On the other hand, the gathering of the shellfish which occurred in quantity in the bays created by the rise in sea level, could easily fit their former way of life and provide them with a food supply capable of supporting a relatively large population. A large population is suggested by the large number of sites found along the edges of the lagoons of the San Diego coast.

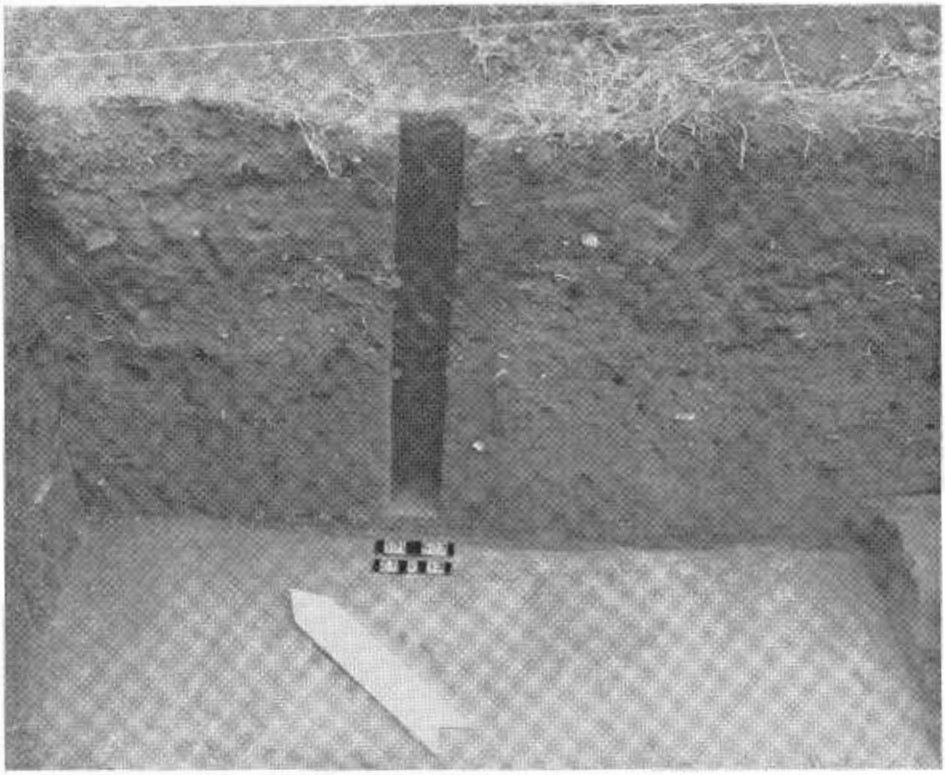
The history of the La Jolla people is recorded in the midden at site SDi-603 on Batiquitos Lagoon. Salvage excavation at this site included not only the recovery of the crude stone artifacts and the recording of the peculiar stone features, but also the taking of samples of the midden in order to discover what the main food resources were and any changes



Stone feature at SDi-603, probably a hearth.

in the economy that might have taken place. This kind of ecological study includes detailed analysis of the stratigraphy of the site as well as actual sampling of the midden. Sampling of the midden is done in a number of ways, none of which are error proof, but which are used in cross checking one another to achieve the most reliable results obtainable. Seldom is it possible to study an entire midden and never is it possible to do so when the archaeologist is racing against time and the bulldozer in a salvage operation.

Three methods of sampling were used at SDi-603. The first type, termed, "column sampling", is truly a sample of the midden, including the dirt, rock and all material within a specific volume of the midden. This kind of sample necessarily is small because of the difficulty of transporting it from the field to the lab where it is analyzed, and because the analysis of it is so time consuming. The technique is so named because the sample consists of a *column* or core 4 inches square running through the depth of the midden. The column is taken in 6 inch segments in order to discover any changes that may occur in the midden composition from the bottom to the top. For example, the bottom 6 inches of the column may include different species of shellfish from the top 6 inches, and thus show a change in the food resources used. Twenty-seven column samples were taken from SDi-603 and are now being analyzed.

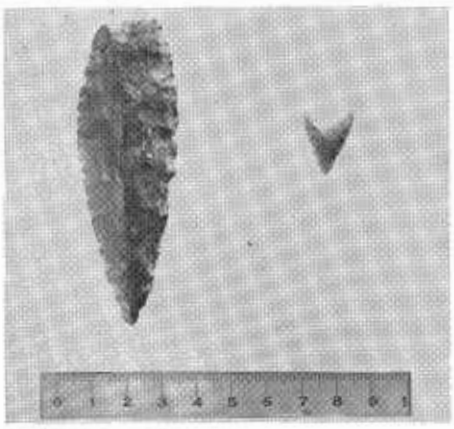


Profile of a five-foot-square pit with a column sample removed. Note how the soil changes from sterile sand at the bottom of the pit to a shell-bearing deposit in the middle and to a stratum containing few shells at the top.

Micro-Analysis

Another kind of sampling, generally called "micro analysis", utilizes a larger quantity of midden than the column sample, but with less control. The unit of the micro analysis is a 5 foot square column running the depth of the midden, taken in 6 inch levels. Each of these levels is passed through a set of screen of ½, ¼ and ⅛ inch mesh. The residue is taken for analysis. The soil is discarded and therefore percentage of the midden components by weight cannot be ascertained. However, the sample of shell, bone and small artifacts such as beads is enlarged, and provides a check for the column sample on these items.

Another type of sample taken at SDi-603 might be called the "whole-shell sample." In this type of sample, the levels were screened through a ¼ inch mesh in an attempt to get a sample of the whole shells present. Again the unit was the 5 foot square, dug in 6 inch levels. The whole shells of this sample are to be studied to determine whether or not, in addition to species changes that probably occurred in the shellfish with the silting in of the lagoon, there was also change within a species, such as a decrease in size or increase in mutations, possibly reflecting a change in the salinity and temperature of the water in the lagoon.

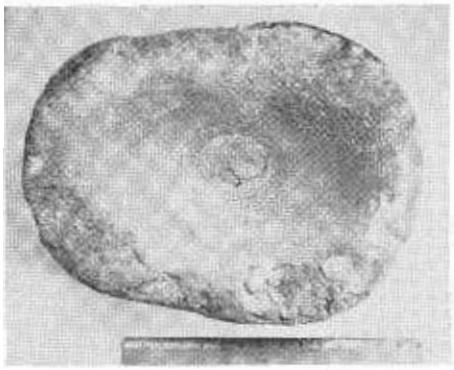


Only two projectile points were recovered from the excavations at Batiquitos Lagoon out of a total of approximately 600 artifacts. The large specimen (above) was from the La Jolla portion of the midden at SDi-603. The small one is from the surface and is typical of points found in San Luis Rey sites.

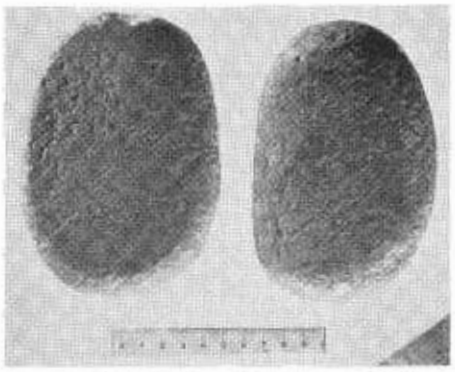
At the time of writing, the samples taken have yet to be analyzed completely, and only the field observations and a very small portion of the micro-analysis pits have been studied. The results as presented here are thus tentative and subject to change upon the completion of analysis of all midden samples. However, the information and interpretations are given here to illustrate how the archaeologist uses these data in reconstructing the culture history of the aboriginal population of the southern California coast.

Strata Are Thin

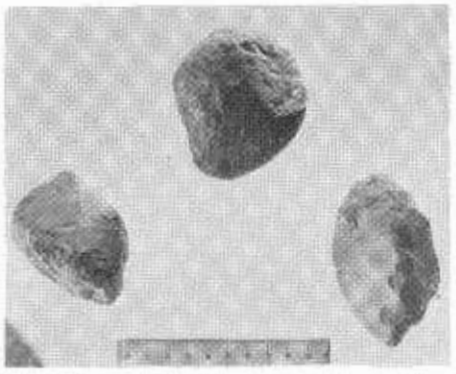
The stratigraphy of the site is only slight and the different strata grade into one another rather than from clear breaks. There appear to be four strata containing remains of human occupation. The deepest and there-



A typical La Jolla metate used with a manos to grind seeds.



A manos from Site SDi-603. Manos and metates are among the most common artifacts in the La Jolla sites, indicating rather extensive use of wild seeds as food.



Hammerstones used for flaking stone in the production of tools.

fore the oldest is 7 to 10 inches thick, a light brown sandy soil containing a few shells and split mammal bones in addition to artifacts. The second stratum is 7 to 9 inches thick, gray brown, compact and containing large quantities of shell and some ash. Nearly all stone features discovered in SDi-603 were located in this stratum. This appears to represent the time when the population was heaviest, since rock features, artifacts and food remains appear to be more common in this stratum than the others. The third level is 10 to 12 inches thick, compact light brown soil which contains only small quantities of shell and other food remains. It apparently represents a decrease in the population. The fourth and last stratum is 6 to 7 inches thick, and represents humus and plowed soil. The soil is loose, lumpy and full of rootlets. The food remains appear to be approximately the same as those of the third stratum.

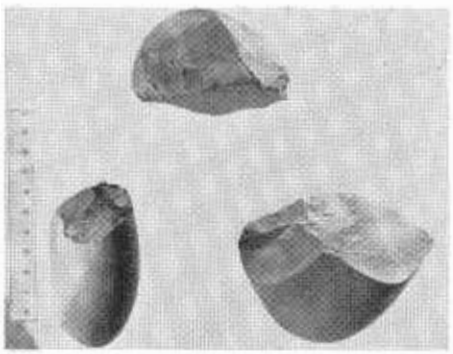
Potsherds, representing the San Luis Rey culture, are found in stratum 4 and the upper half of stratum 3.

In addition to the quantitative differences in food remains of the strata, there also appear to be qualitative differences. The earliest stratum seems to contain relatively more split mammal bone and more rock-dwelling shellfish such as mussels than the upper levels. Starting with the second level, there appears to be a shift toward the shellfish which live in mud or sand and fewer mammal remains are found. If this is true, two occurrences may be reflected in these remains: the lagoons were becoming silted in so that the rock-dwelling mussels were more scarce, and the La Jolla people were depending more heavily on the food reserves of the lagoon and not hunting land mammals as before. This is also the time when the population appears to be the heaviest.

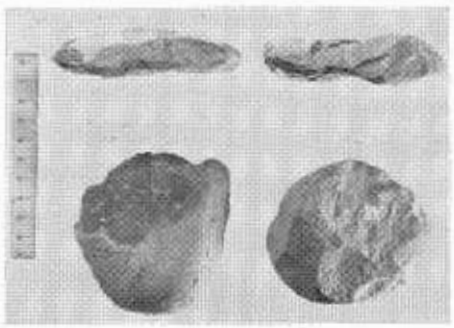
Silting of Lagoon

Stratum 3 probably represents the period when the silting in of the lagoon had reached a critical point and it could no longer support shellfish in any quantity. What happened to the people of the La Jolla culture when this happened remains one of the problems to be solved. However, the midden at SDi-603 suggests that the population diminished when the shellfish supply dwindled; the La Jolla people either moved elsewhere or the population dwindled too. It is through excavation sites such as SDi-603 and the study of their remains that what happened to these people may be found out.

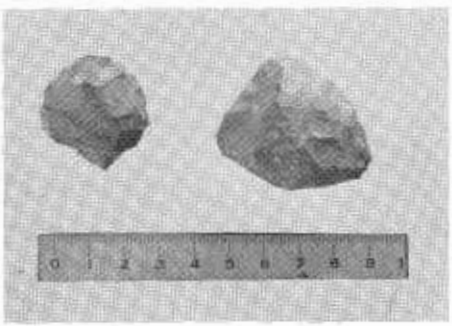
The San Luis Rey people came into the area late, and represent the Luiseno and probably Diegueno Indians of historic times. The San Luis Rey culture represents a migration of Shoshonean and Yuman speaking peoples into the coastal areas from the desert region to the east. SDi-603 is near the border between the Shoshonean speaking Luiseno and Yuman speaking Diegueno and may have been occupied by either or both groups. The very limited cultural inventory representing the San Luis Rey culture (potsherds and 1 projectile point, plus a few scraping tools) found at this site



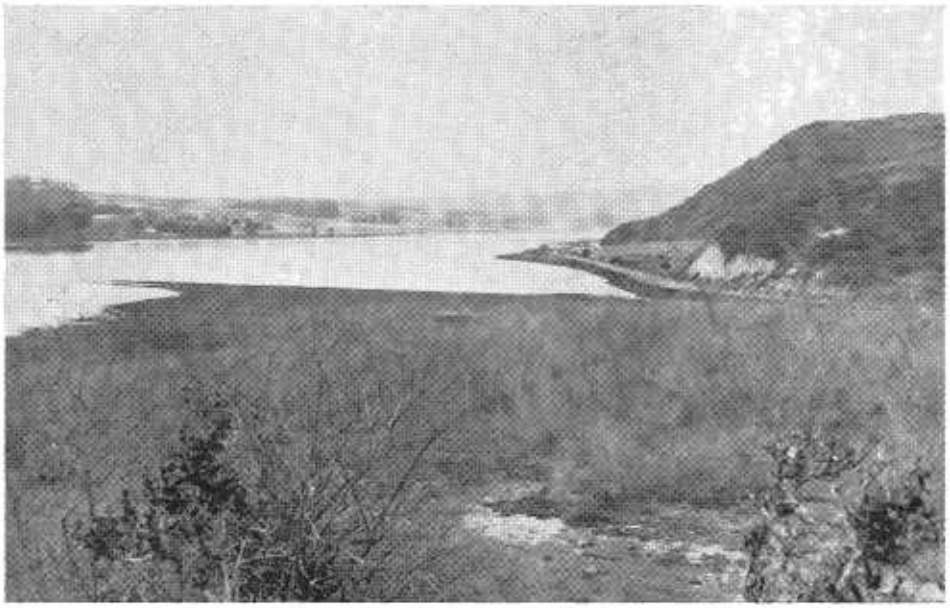
Large scrapers and choppers common in La Jolla sites.



Small scraper-chopper combination tools from Site SDi-603. Some combination tools are common in La Jolla sites. The two to the left are profile views.



Small, well-made scrapers are almost always present in La Jolla sites.



Batiquitos Lagoon during the winter months. During the summer the lagoon becomes completely dry.

suggests that it was inhabited only seasonally and then for short periods of time.

Though much remains to be learned about the prehistory of the San Diego coast, the salvage operations at SDi-603 and SDi-211 have been and will continue to be a great help in the reconstruction of past cultures of the area. The cooperation of the Division of Highways, State Division of Beaches and Parks, and the University of California Archaeological Survey, Los Angeles, has made of the construction of present freeways a means for the reconstruction of past cultures. Modern highways thus enrich our lives with not only the benefits of modern engineering and technology, but also the knowledge of man and cultures of the ancient past.

Acknowledgments

The authors wish to thank Mr. J. Dekema, Mr. J. F. Jorgensen, Mr. J. M. Damberger, Mr. C. Wigginton and Mr. Ralph Davis of the Division of Highways office in San Diego for their assistance in this project; Mrs. Mary Barnes, the Reverend William Savage, Mr. Perry Lamb and Mr. and Mrs. Laddie Pottroff for permission to excavate on their property before it had been purchased by the State; Dr. Carl Hubbs, Mrs. Jackie Miller and the other members of the staff and faculty at Scripps Institution of Oceanography for their interest and aid in the excavations. We would also like to thank the Ed Fletcher Company of El Cajon, California for use of their building near the site as field headquarters, and to thank Mr. Jack Dyson and Mr. Francis Riddell of the State Division of Beaches and Parks, and Mr. W. L. Warren and Mr. Oliver Arnold of the State Division of Highways for their cooperation in obtaining and executing the contract for the salvage operations at the sites.

I.T.E. to Sponsor World Conference

The Institute of Traffic Engineers will sponsor a World Traffic Engineering Conference in Washington, D.C., from August 21 to 26. The conference will combine the 31st Annual Meeting of the Institute with the International Sessions in Traffic Engineering. The conference will be the first of its kind and will be attended by traffic engineers and highway officials from all over the world.

Discussion panels and lectures will be held on all phases of traffic engineering during the six-day conference.

Reports on design of interchanges and rural freeways will be made by representatives from Australia, Belgium, France, Germany, Japan, Mexico, the United Kingdom and the United States.

Panel participants from the California Division of Highways will include Karl Moskowitz, Assistant Traffic Engineer, and George A. Hill, District Engineer of District VII in Los Angeles.

A one-week tour by bus following the Conference is being planned for those interested in studying some of the traffic and design problems first hand.

Twenty Employees Win 25-Year Awards

Headquarters Office
Edward J. Carter
Joseph C. Lacey, Jr.
Harriett A. McDannald
Paul R. Watson, Jr.
Wyatt C. Winkler

District I
Emil Wurche

District II
George R. Bradley
Paul K. Miles

District IV
A. G. Bertollozzi
Antoinette K. Casey
Aurora Douglas
Hugh G. Munro

District V
Thrale H. Milburn

District VIII
Leonard P. Heiner

District X
Charles E. Nuding

District XI
Aurelia B. Rinderneck

Bridge Department
August E. Dirckx

State-Owned Toll Bridges
John A. King

Headquarters Shop
Gertrude E. Haddick
John C. Tibbitts

Whiskeytown Fill

New Dam Requires U.S. 299 Relocation

By R. J. FELTON, District Construction Engineer

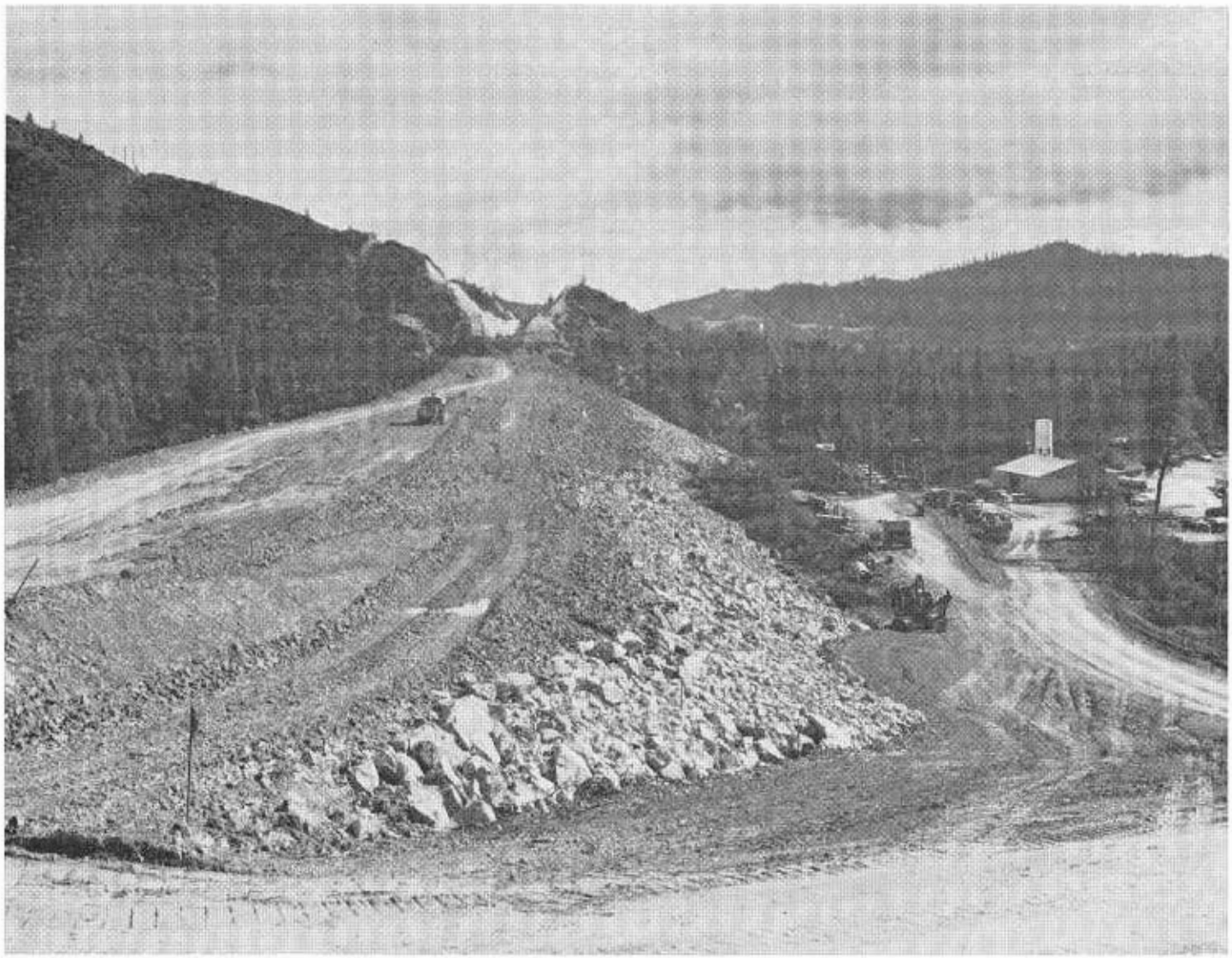
IN JANUARY, 1960, Gibbons and Reed Construction Company of Salt Lake City, began the relocation of five miles of State Highway U.S. 299 through the historic settlement of Whiskeytown in Shasta County 11 miles west of Redding. An interesting feature of the project is the westerly approach embankment constructed for the crossing of Whiskey Creek.

Relocation of the existing highway became necessary with the advent of Whiskeytown Dam currently being constructed on Clear Creek 2 miles downstream from the townsite. The existing highway, as well as the townsite, will be inundated by a 3,250 acre lake storing 250,000 acre feet of water that will be created by the dam constructed as a portion of the Trinity River Project.

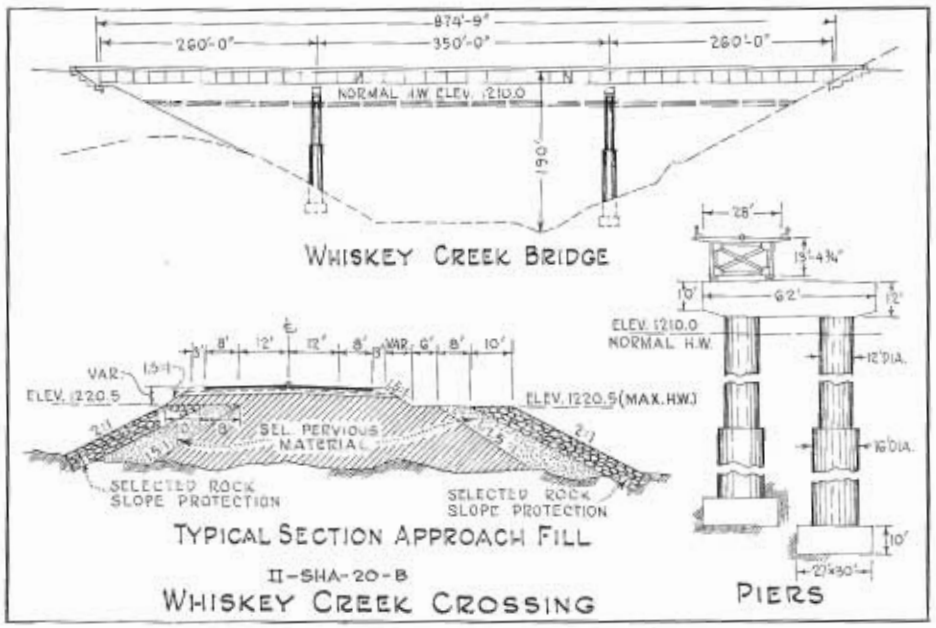
Was Control Point

Whiskey Creek is a tributary to Clear Creek and was the major control point in selecting the route for the highway relocation around the reservoir. The Whiskey Creek arm of the future lake offered a gap one-half mile wide and up to 190 feet in depth to be spanned.

The design selected consists of 875 feet of structure spanning the deepest portion and 1800 feet of embankment to serve as the westerly approach. The



Partly completed embankment across Whiskey Creek Arm viewed from west end. The benched cuts are on the east side of the creek.



Embankment typical section and bridge profile.

embankment has a maximum height of 160 feet and will be submerged to a maximum depth of 140 feet. The submergence of the embankment subjects it to some of the hazards encountered in earth fill dams. Changes in internal hydrostatic pressure due to rapid decrease in water elevation had to be considered.

The design of the embankment is similar to that of an earth fill dam. The core is constructed of impervious soil encased in a shell of pervious rocky material protected by a 10-foot facing of selected rock on a 2:1 slope. The embankment contains a total of 1,220,000 cubic yards of material. The core contains 797,000 cubic yards and there are 330,000 cubic yards of selected pervious material and 93,000 cubic yards of selected rock slope protection in the outer layers.

All of the materials in the one embankment were obtained from roadway cuts and represent 44% of total earthwork on the project.

Tests Made

During the course of constructing the embankment, permeability tests were made on the selected pervious material to insure that the pervious zone will be free draining and devoid of internal hydrostatic pressure. The weight of the pervious material and rock slope protection is designed to prevent failure of the embankment core. During long periods of submergence the embankment will develop an internal hydrostatic pressure equal to the pressure of the water on the embankment. When the water level is drawn down rapidly the differential between the hydrostatic pressure within the impervious embankment core and the atmospheric pressure outside actually causes a tendency for the embankment to slump and fail.

The rock slope protection will also protect the embankment against wave action.

The constructed grade line on the embankment will be one foot higher than the planned ultimate grade to allow for subsidence of the original ground and settlement of the embankment due to submergence.

Two-lane Expressway

Basically the project consists of constructing a two-lane expressway to a 40-foot roadbed width. At the Whiskey Creek crossing the embankment width, up to maximum high water elevation, is designed to accommodate a future 4-lane 60-foot all-paved roadbed. The substructure of the bridge is also designed to accommodate 2 additional future traffic lanes.

In May, 1961, the earthwork on the project was 95% complete and work was in progress on the abutments and the two piers of the bridge. The plate girder type bridge has an unusually long center span of 350 feet.

Financing of the project is shared jointly by the Division of Highways and the U.S. Bureau of Reclamation. The Bureau's share of approximately 90% is based on a "replacement in kind" cost. The State's share of the cost of the new construction provides for greater width and superior geometric standards to those of the existing highway.

The project was designed by State personnel and construction engineering is provided by the State, with B. L. Borup and M. P. Brower as resident engineers. The project will be completed in the fall of 1961 at a cost of $4,200,000.

J. J. DuCray in New Administrative Post

Appointment of Justin J. DuCray as Senior Administrative Analyst in the Department of Public Works has been announced by Director Robert B. Bradford. He will perform the duties of the Departmental Management Analyst in the position held by John H. Stanford until his appointment as Assistant Director.

DuCray began his career with state government in 1947 as a field office manager with the Department of Employment. After holding several positions in administrative work with Employment, DuCray transferred to the Department of Public Works in 1957 as an associate administrative analyst.

WARMTH HELPS ROAD OPENINGS

The light snow pack and warm weather facilitated early opening of the high Sierra passes and other snow-closed roads, all of which were open by May 4 except the Lassen Loop Highway maintained by the National Park Service. Total snowfall for the season at Donner Summit amounted to 285 inches, with an 8-inch snow pack at the end of April. This compared with a 279-inch snowfall last season, with a similar light snow pack.

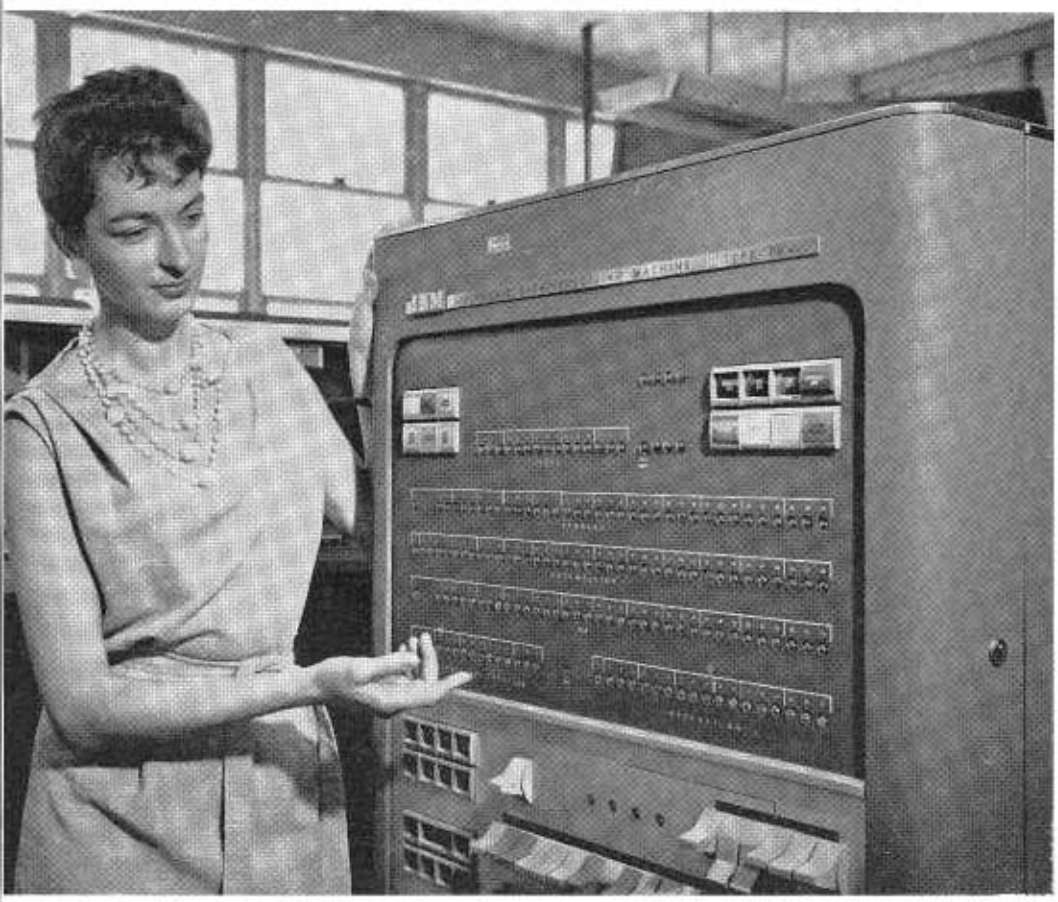
The California Highway Commission has allocated an additional $265,000 for reconstructing base and surfacing on sections of State Sign Route 1 between Davenport and Princeton in Santa Cruz County.

Accounting Modernizes

In building highways, as in virtually all phases of modern technology, there is a constantly increasing cost of producing the detailed and complex information about operations which is necessary as a guide for continued efficiency. Hand in hand with this problem of increasing costs, there has also been increasing delay in extracting the necessary facts and figures from the record keeping systems. Early in the research for possible revision of the accounting system, it was obvious that to provide current data as needed it would be necessary either to expand the cost distribution system and accumulate the additional information by the use of bookkeeping machines, or to abandon the present system in favor of data processing equipment with electronic speeds.

For more than a decade the Division of Highways has been using some form of electronic computer to perform engineering calculations, progressing from the more primitive early types to the highly complex ones now used. In the Planning Survey Data Processing Center, many thousands of man hours have been saved by the machines during that period.

It should be kept in mind that the hours saved were engineer man hours, which until the installation of the computers, would have been expended in operating calculating machines. Not only have the machines relieved the engineer so that he has time to do the design work he is trained for, but they also help him in his design work. The speed of calculation allows him to investigate a number of design solutions for a bridge, for instance, and quickly discard all but the best and most economical solution.



Martha Laird of Headquarters Office points to one of the latest type computer and storage bank machines already installed at Sacramento. The new accounting machines will record district information on tape which can be fed into this machine and others like it.

More Information Faster

To satisfy modern management's demand for more and more information with ever more refinements, many other big organizations have turned to the science of electronics for a solution. It was decided that the Division of Highways could best profit by the adoption of an automatic data processing system. The alternative would have involved the acquisition of additional bookkeeping machines, the hiring of additional personnel and the enlargement of physical facilities of the District Accounting Departments. Even with the expenditure of considerable additional funds, it was doubtful that such a system would be able to satisfy the ultimate demands upon it. In recent years it has become apparent that due to the problems of complexity and costs, further mechanization of a Division's accounting system would be warranted. Cost analysis, for instance, could not be readily furnished upon request except through costly and time-consuming post-analysis of the accounts.

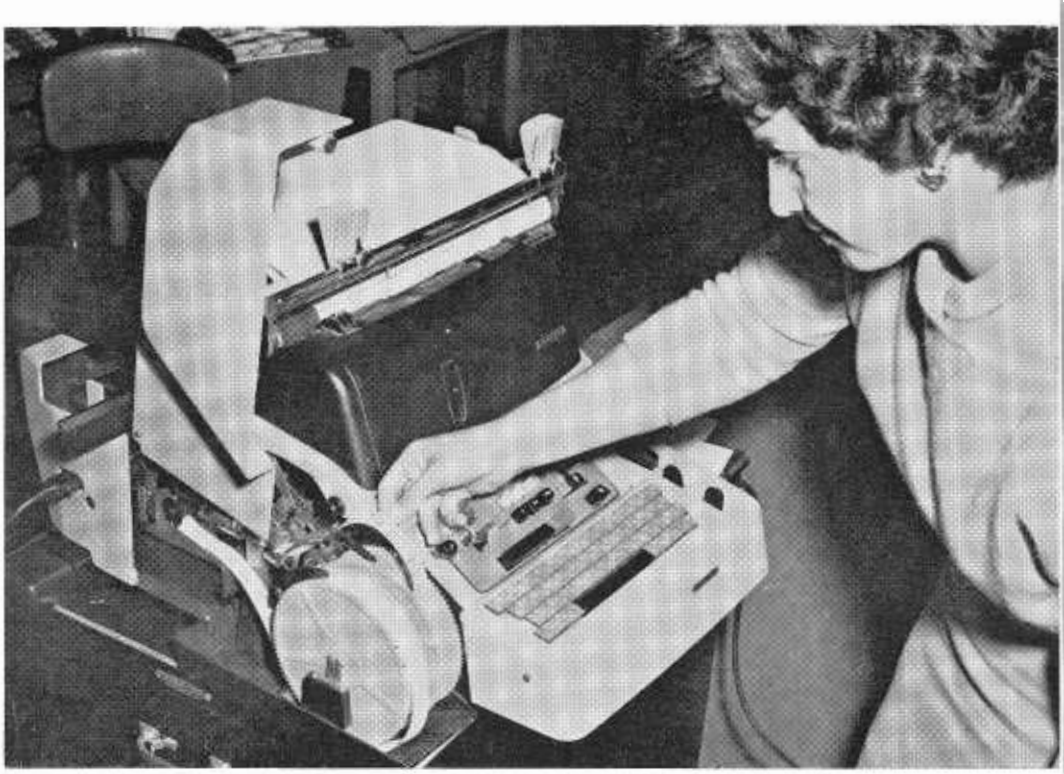
Two Years Research

In the preliminary research which began in 1959 to find the best electronic system to take over the load, it was determined that only two types of in-put for automatic data processing would be suitable. The first method would require sending all source documents to Headquarters Office in Sacramento for key punching into the familiar punched card. The second would provide for data to be converted at the District level into a form acceptable to the Headquarters Office data processing equipment.

As planning for changeover progressed, considerable helpful advice was obtained from the Data Processing Center in the Planning Survey section which, of course, had a considerable fund of general experience with computers.

Where possible, changes in accounting procedure under consideration anywhere in the Division were considered in the light of applicability to a new system. For example, a change in the arrangement of code numbers on work orders was made effective July 1, 1960. The new number system was designed so it would fit smoothly into an electronic accounting system.

In January of this year a pilot study was put under way in District X, Stockton, to determine the effectiveness and practicability of creating the original data processing medium at the District level. An accounting machine with a punched paper tape by-product was chosen. While entries are being posted to conventional ledger cards, a punched paper tape is being produced showing the same entry, only in greater detail. The tape produced is then forwarded to Sacramento where the tape is converted to punched cards.



Lou Perez of Headquarters Accounting Department shows tape mechanism and storage reels on new type bookkeeping machines.

Accounting Machines Best

The results of the pilot study indicated that posting expenditure authorization ledgers in the District offices was both desirable and necessary in either system. The key punch method would require immediately at least sixteen additional key punch operators, and sixteen key punches and verifiers in Headquarters Office. The cost of key punch equipment and the salaries for additional employees was far greater than the cost of accounting machines with punched tape output and a tape-to-card converter. Using the accounting machines permits our present personnel to perform basically the same work they are now doing and for which they have been trained. Controls will still be maintained in the Districts where questions concerning accounting, coding and other matters can be answered immediately, thus eliminating communication problems between the Districts and Headquarters Office.

Accounting machines with tape outputs and a tape-to-card converter have been purchased. The accounting machines are being placed in the District offices for use on the normal accounting work and a punched tape record of the data will be produced automatically.

Conversion Starts Immediately

On July 1, 1961, the Headquarters, District, and Bridge Department accounting will be converted to the new system. Studies will be made for possible conversion to the new system of the Equipment Department, Materials & Research, Inventories, and Toll Bridge accounting. It is believed that the new system will provide management with all the data now required at high speed and at a saving in cost and that it can be expanded to meet future needs.

Left: Marian Ariff of District X Office at Stockton operating one of new machines, which are little larger than typewriter, need no special installation.

Needles

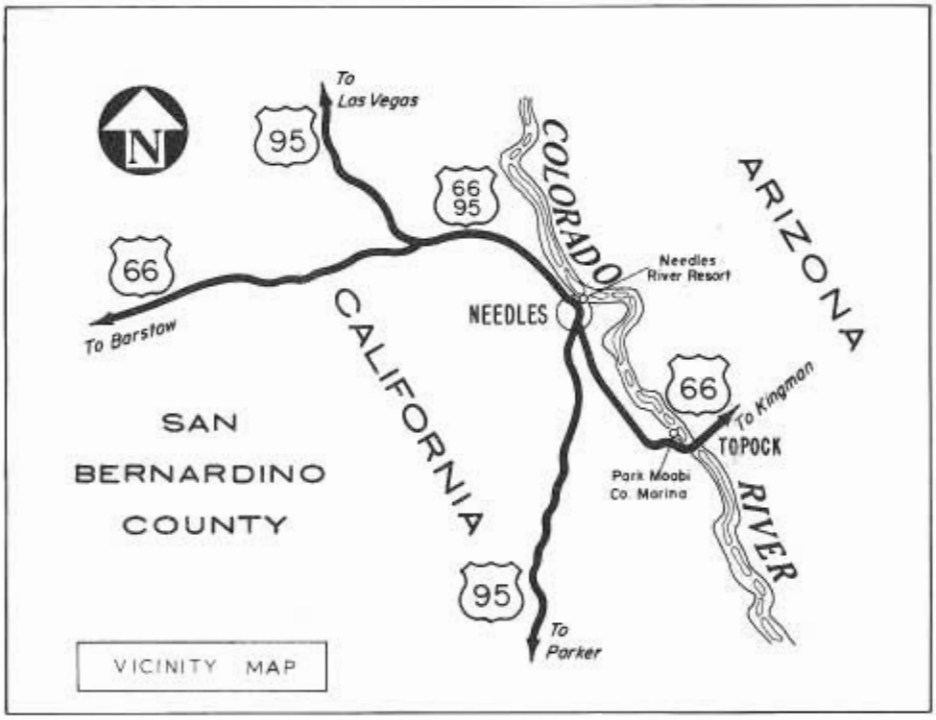
U.S. 66 Through Downtown Area Is Four-laned, Straightened

By L. M. BARNETT, Construction Engineer and C. M. MAUCK, Resident Engineer

IN KEEPING pace with the City of Needles' expanding economy of tourism and recreation, local and interstate traffic has recently been provided a safer highway with increased capacity. The interim construction, pending a freeway bypass, was financed jointly by State Highway Funds, Major City Street Funds, and the City of Needles through an Assessment District. It was administered by the City.

This improvement is in sharp contrast to the transportation facilities of the early 1900's when transportation in the vicinity of Needles was by stern-wheeler boats (on the bordering Colorado River), railroad, horseback, and by a few automobiles utilizing dirt trails that had brought the covered wagons to California.

The Colorado River was the most formidable early barrier to traffic. To cross the river, several different types of transportation facilities were used in various combinations. For a while, a barge, pulled by a puffing motor ferry, carried cars across during limited times when river conditions were favorable. In high water, the river was too swift for a safe crossing, while at low water, even the shallow draft flat boats mired when carrying an automobile.



Planks Are Laid

The Santa Fe Railroad assisted these pioneer motorists by permitting planks to be laid alongside the rails on its nearby Topock Bridge. Autos were allowed to cross whenever the tower man signaled that no trains were coming from either direction.

After about 5 years, the increase in automobile usage made this operation too hazardous. In 1916, a steel arch bridge was erected at Topock for the

Looking east toward Needles showing new curb and gutter with surfacing striped for four lanes.

County road, which later became State Highway (U.S. 66).

During World War II, the Santa Fe built its present railroad bridge. The old steel span of 1889 became the highway bridge and the lighter steel arch of 1916 began serving as a cradle for a huge gas main.

The covered wagon trails were progressively widened and straightened, with oil eventually being added to settle dust. This expanded, in the 1920's, into the use of thin blankets of road-mixed asphalt surfacing. However, in 1959 the main highway through Needles, although paved, was not adequately handling the increased local and through traffic. The road consisted of badly broken pavement, steep gradients, and dangerously sharp curves. It was striped throughout for only two lanes; however, frustrated motorists frequently used portions as a narrow four-lane facility.

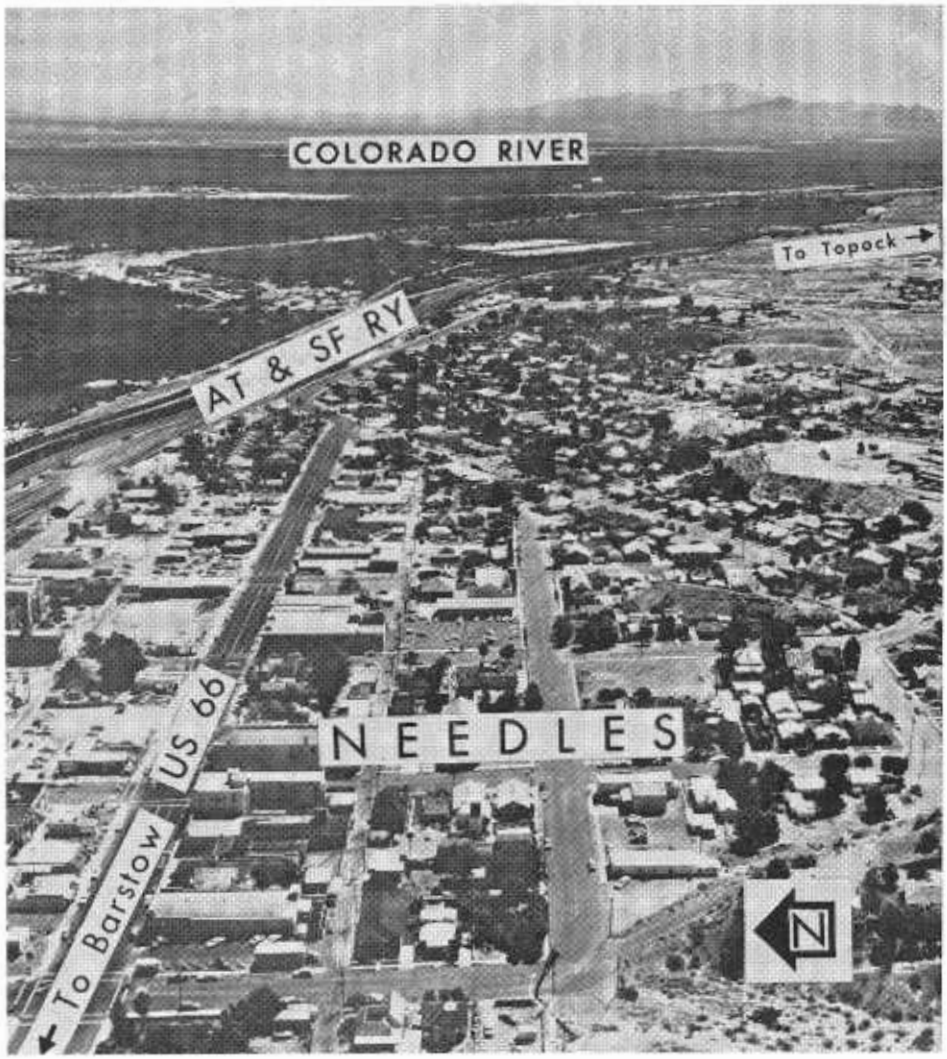
Through the cooperative efforts of City Administrators, a project, consisting of two contracts, was set up to improve this thoroughfare.

Example of Cooperation

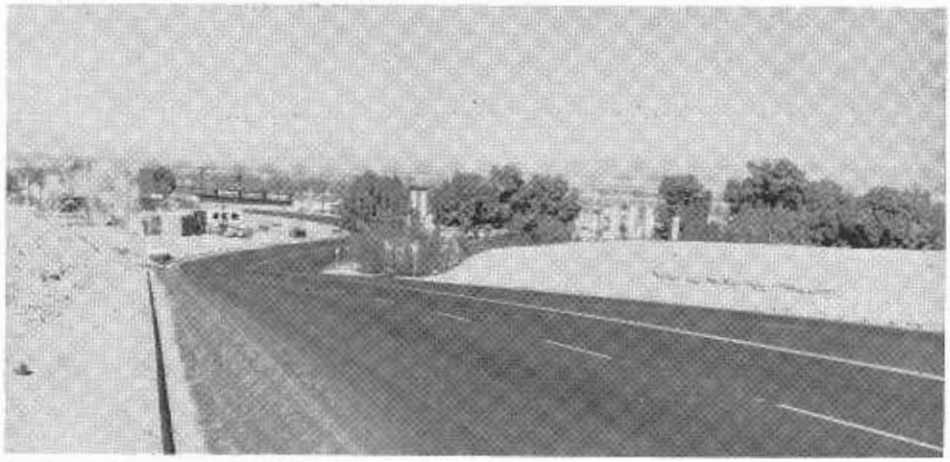
This project, from the planning to the final construction stage, was a good example of cooperation between cities and the State. City personnel handled nearly all phases of the project from its inception to letting the construction contract and administration thereof. They prepared the plans and other contract documents, with the State furnishing assistance as to required standards and procedures, etc. The City also acquired the necessary right of way and handled the utility relocations.

The project added sufficient width to provide for four moving lanes, two parking lanes and curbs and gutters, and resulted in improved grade, horizontal alignment and superelevation. The roadway was blanketed with a smooth-riding surface of asphalt concrete.

Total project costs were approximately $210,000, shared as follows: $118,000 from State gas tax funds, $14,000 from City gas tax funds, and $78,000 from funds provided by an Assessment District following procedure provided for by the 1911 Bond Act.

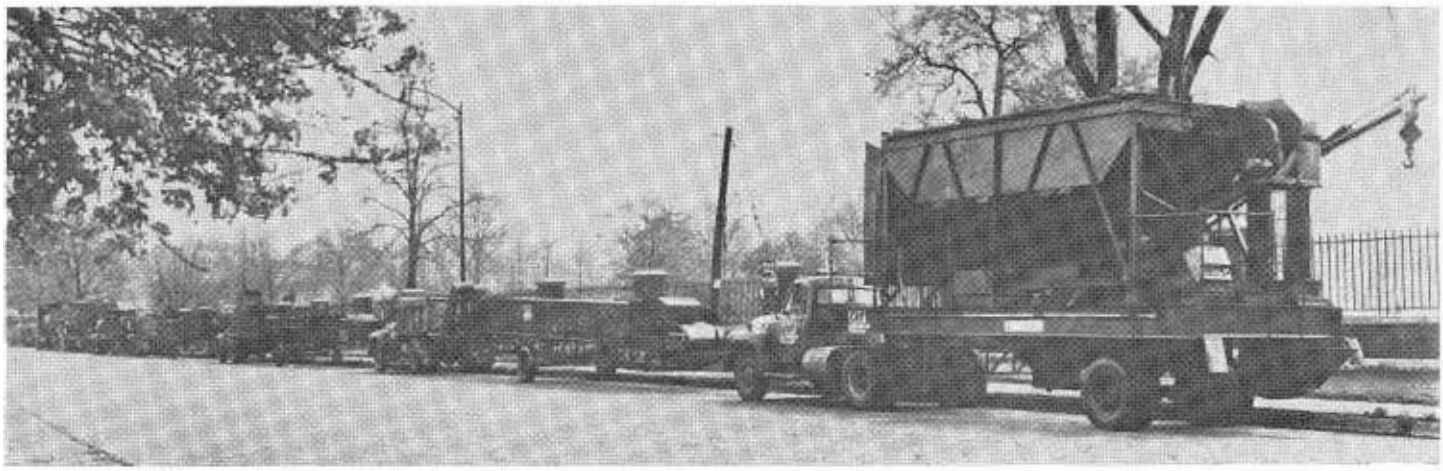


An aerial of reconstructed U.S. 66 through downtown Needles.



Looking northwest toward Needles showing the widening of the roadway with improved grade and alignment.

City officials instrumental in setting up and administering the project include: H. L. Smith, Mayor; W. Jacobson, City Manager; J. R. Smith, Director of Public Works; Don C. Davis was consulting engineer. The State



The complete mobile asphalt concrete plant ready to roll.

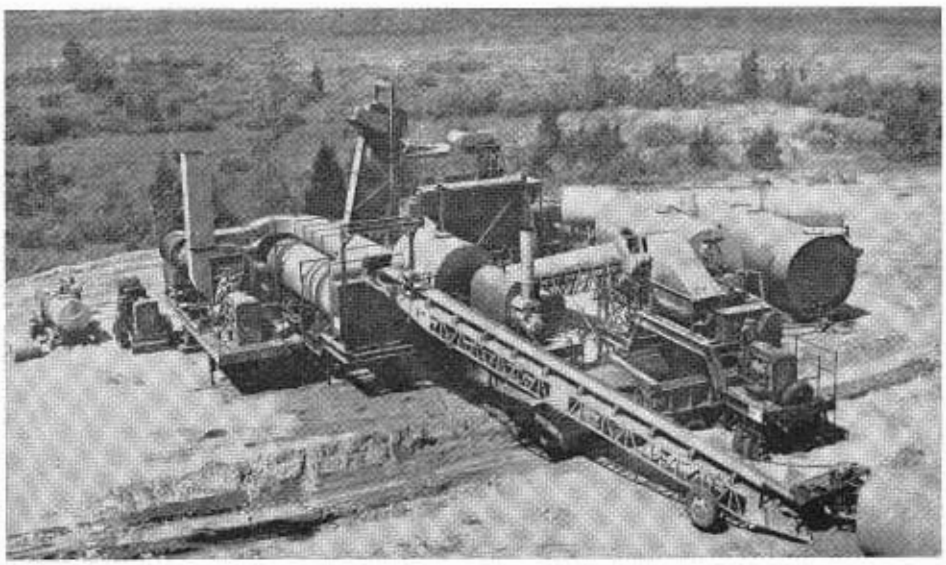
resident engineer assisted in inspection of paving operations at the request of the City.

Mobile Plant Used

The firm, Scott and Scott Contractors of Sun Valley handled the grading and paving, with C. Bode as superintendent. They used a highly mobile, 4,000-pound, batch-type, asphalt concrete mixing plant.

A summary of the more important features of this plant is:

1. Mobility Features
   Each major plant unit has permanently mounted transporting wheels.
   The plant is self-erecting with built-in hoisting equipment and hinged jack legs to assist in rapid dismantling and resetting. No crane is required.
2. Layout (See Plot Plan and overall photograph of plant).
   The plant is spread out close to the ground, in contrast to higher "stack-up" plants.
3. Capacity
   The manufacturer rates this Model 40 unit at 140 tons per hour. (A fair production check could not be obtained on this project.
4. Operation
   The entire feed and mixing cycles are controlled automatically, and can be operated by simply pressing one button. (The plant can be switched to manual operation as desired.) The pug mill receives the weighed aggregates by conveyor belt and the asphalt by an automatic volumetric calibrating device (fluidometer), after which the materials are mixed a predetermined length of time and then discharged into the trucks. The automatic cycle control prevents other than a predetermined amount of aggregate and asphalt being used in the mix. A weight check of the volumetric measurement made by the fluidometer indicates it is quite accurate. (It should be considerably more accurate than the batch-weighing method.)



Typical layout of the mobile asphalt concrete plant.

Although a test of the full potential of this plant was not possible due to the short sections of this project, it seems to have definite advantages in its mobility and self-erecting features.

The City Administrators of Needles have also worked cooperatively with State and Federal personnel to locate the route of the future interstate freeway, complete with modern-type interchanges, through the City of Needles.

While these modern freeway plans are being developed, the newly improved highway facility should safely and comfortably accomodate the tourist who has already discovered this desert wonderland.

The State Department of Public Works has awarded a $873,000 contract to construct a mile of freeway and the Ethanac Overhead and Interchange on U.S. 395 east of Perris in Riverside County.

Asphalt Test

Ten Different Road Samples Show Varying Durability

By ERNEST ZUBE, Supervising Materials and Research Engineer

INTRODUCTION

THE CALIFORNIA Division of Highways in common with other agencies has for a good many years been interested in the quality of paving asphalts.

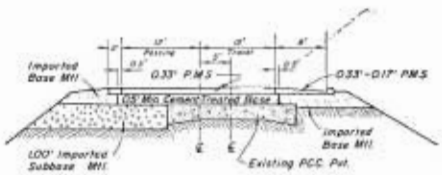
This paper was presented at the Tenth Arizona Roads and Street Conference, Tucson, Arizona, November 17-18, 1960.

It has been our observation that many asphalt pavements after a comparatively few years of service have shown signs of distress in the form of cracking, ravelling and general evidence of becoming brittle.

Crude petroleum in California is produced in three major areas: The Los Angeles Basin, the Kern Basin and the Santa Maria area. Asphalts from the Los Angeles and Kern area are somewhat similar in properties, but asphalt produced from the Santa Maria area exhibits somewhat different characteristics. Although the engineer is concerned with several properties of the asphalt, certainly the most important is durability. The materials and Research Department has been working on the problem seeking to develop testing methods and test limits that would exclude asphalts having a poor durability record. As a result of this work, a trial specification was developed in 1954 which has been referred to at times as the specification for "premium" asphalt. In order to determine the performance of asphalts complying with the new requirements, it was decided to place a series of test sections commonly known as the Zaca-Wigmore test road.[1] Actual construction took place during 1954 and 1955. Ten different asphalts were used. Failures have developed in some of the sections while others are still in quite good condition. It must be emphasized that these marked differences in performance exist even where all conditions of construction, aggre-

FIGURE 1

TYPICAL STRUCTURAL SECTION
NEW ALIGNMENT



TYPICAL STRUCTURAL SECTION
OVER EXISTING PAVEMENT

FIGURE 2

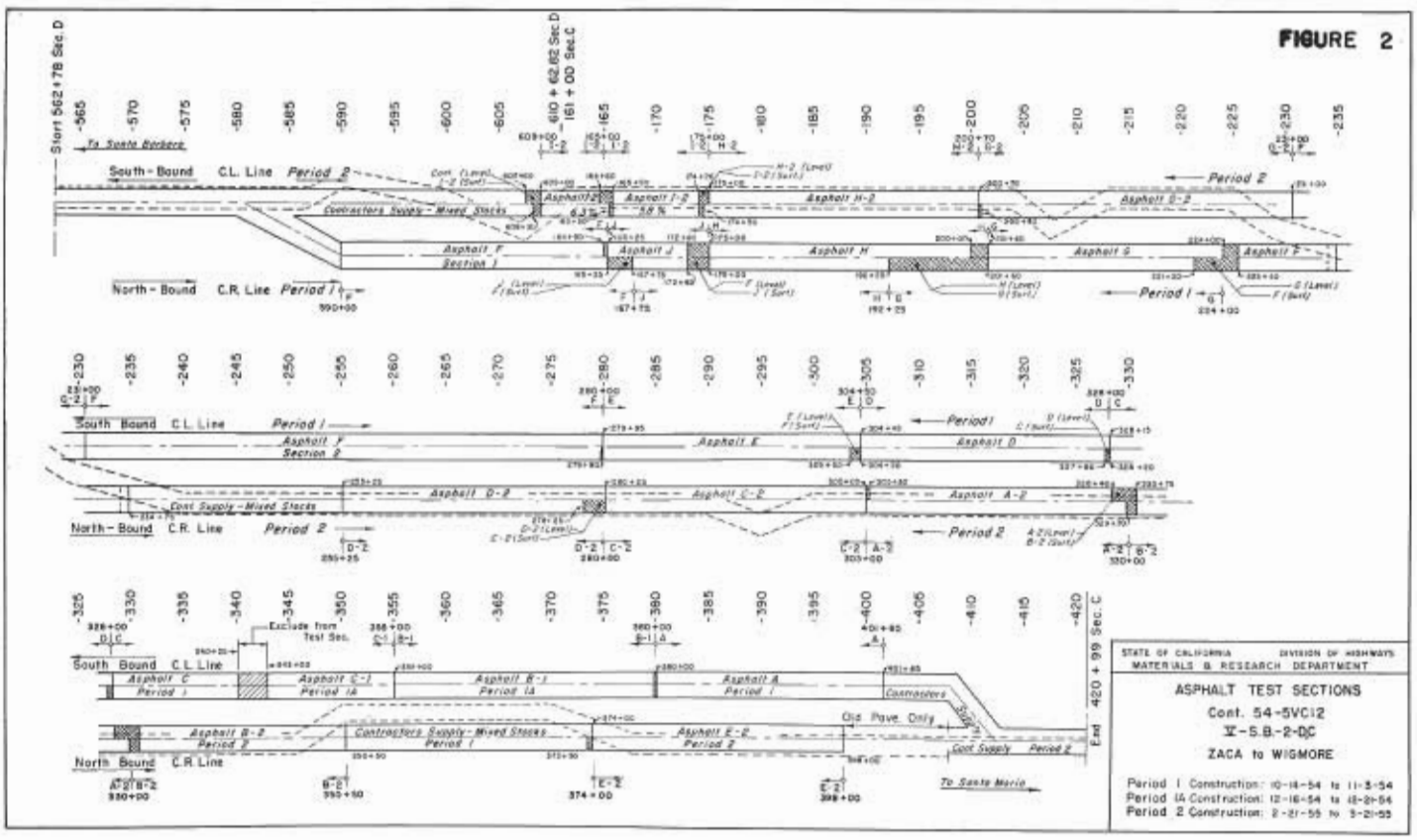


TABLE I

Average Paving Mixture Test Properties of Laboratory Compacted Specimens

	Paving Period	
	I, IA	II
Per Cent Asphalt Used	5.5	5.8
Per Cent Asphalt Extracted	4.7	5.0
Spec. Grav.	2.16	2.21
Stab. 140°F.	41	42
Cohesion 140°F.	142	246
Swell (Inches)	0.002	0.003
Grading—% Passing:		
¾	100	100
½	87	85
⅜	76	70
4	59	51
8	48	39
16	40	32
30	30	24
50	18	15
100	9	9
200	6	6

gates and quantity of asphalts were quite similar.

Project Description

The project is located on U.S. 101 in Santa Barbara County, about 150 miles northwest of Los Angeles and, to the best of the author's knowledge, is the largest experimental asphalt installation of its type in the world. Zaca and Wigmore were originally stations on the now abandoned Pacific Coast Railroad. Although these stations are no longer in existence the names serve to identify the termini and the job is now referred to as the Zaca to Wigmore test road.

The project consisted of converting an existing two lane highway into a four lane divided expressway by constructing two new lanes and widening the existing pavement.

Based on soil surveys and an anticipated ten year traffic estimated weight load of 10.7 million, the structural typical section for the new alignment consisted of 1.0′ imported base material, 0.67′ of Class B, cement treated base and 0.33′ plant mixed surfacing (asphaltic concrete) Type B.

The existing facility constructed in the early 30's consisted primarily of an old P.C.C. pavement and was in fair to poor condition. The new design provided a minimum of 0.5′ Class B, cement treated base to be placed over the present pavement and to be surfaced with 0.33′ of asphaltic concrete. The existing concrete pavement was subsealed with asphalt prior to placing the new cement treated base. The roadway was widened to provide a geometric section similar to the new construction. The typical sections for both new and existing pavements are shown in Fig. 1.

Layout of Test Sections

It was decided to place the test sections in duplicate and make them as long as possible. A long test section has a definite advantage in that it provides average conditions of construction and also provides a better basis for future comparison of performance. Whenever possible, the test sections were placed so that asphalt from the same refinery would be used in two locations—one on the new alignment and one section over the existing pavement.

A final test section length of approximately 2500′ for each asphalt was selected, with the exception of two special asphalts where the available supply prevented the placing of duplicate and full length sections.

Selection of Asphalts

Considerable thought was given to the grade of paving asphalt to be used on the project and finally the 200-300 penetration grade was selected, the reason being that the district in which this project was planned had used this grade on previous projects to the north and south of the test project on Route 101, and thus permit a comparison of the performance of the test asphalts with other 200-300 penetration grades.

TABLE II

Average Properties of Pavement Cores Removed from the Outer Wheel Track of the Travel Lane

Asphalt	Paving Period	Age Mo.	Relative Density Per Cent	Weight Per Cu. Ft. Lbs.	Per Cent Voids	Per Cent** Relative Compaction	Stability	Cohesion 140°F
A	I	59	93.7	138	6.3	102.2	38	249
A-2	II	55	97.9	142	2.1	104.1	32	289
B-1	IA	57	95.9	141	4.1	102.6	35	425
B-2	II	55	94.9	138	5.1	100.0	32	408
C	I	59	93.2	137	6.8	101.4	38	239
C-1	IA	57	96.6	142	3.4	105.1	24	328
C-2	II	55	96.2	140	3.8	102.3	29	339
D	I	59	93.7	138	6.3	101.3	39	175
D-2	II	55	97.1	141	2.9	101.8	34	242
E*	I	35	89.8	132	10.2	99.1	26	249
E-2	II	55	95.4	138	4.6	100.8	33	553
F*	I	35	91.4	134.5	8.6	101.0	35	141
G*	I	35	90.9	134	9.1	99.8	33	314
G-2	II	55	95.4	138	4.6	100.4	34	535
H	I	59	93.2	137	6.8	101.4	36	110
H-2	II	55	97.4	142	2.6	102.3	30	277
I-2—5.8%	II	55	95.7	139	4.3	101.3	39	645
I-2—6.3%	II	55	97.1	141	2.9	101.3	31	494
J	I	59	91.1	134	8.9	100.5	35	217

* These sections failed between 35 and 59 Mo.
** Per cent relative compaction based on laboratory compaction equals 100%.

TABLE III
Specifications for Paving Asphalts

Specification Designation	1954 Standard Specifications		1954 Special Provisions	
	A.A.S.H.O. Test Method	Specification Requirements	A.A.S.H.O. Test Method	Specification Requirements
Flash Point, Cl. O.C. °F., Min.	T48	350	--	--
Flash Point, P.M.C.T. °F., Min.	--	--	T73	400
Penetration of Original Samples, 77°F.	T49	200-300	T49	200-300
Loss on Heating, 5 Hr. at 325°F., % Max.	T47	3.0	T47	1.0
Penetration After Loss on Heating, % of Original, Min.	T49	60	T49	75
Original Ductility at 77°F., cm., Min.	T51	100	--	--
Penetration Ratio: Pen. 39.2°F—200 gm—1 Min. / Pen. 77°F—100 gm—5 Secs. × 100	--	--	T49	25 Min.
Furol Viscosity at 275°F., Sec.	--	--	--	40-125
Solubility in CS_2, % Min.	T44	99.5	--	--
Solubility in CCl_4, % Min.	T45	99	T45	99
Xylene Equivalent, % Max.	Sec. 6 Chap. II Std. Spec.	35	T102	30

At the time the test section was proposed, the Materials and Research Department was engaged in the preparation of new specifications for paving grade asphalts. It was decided to obtain asphalts (meeting the new specification requirements) from the three principal crude sources in California which would also include different methods of production. In order to compare these new specification asphalts with those conforming to our 1954 Standard Specifications, two asphalts meeting the 1954 Standards were selected from different crude sources. One of the asphalts had very good test properties while the other just barely complied with the old 1954 requirements.

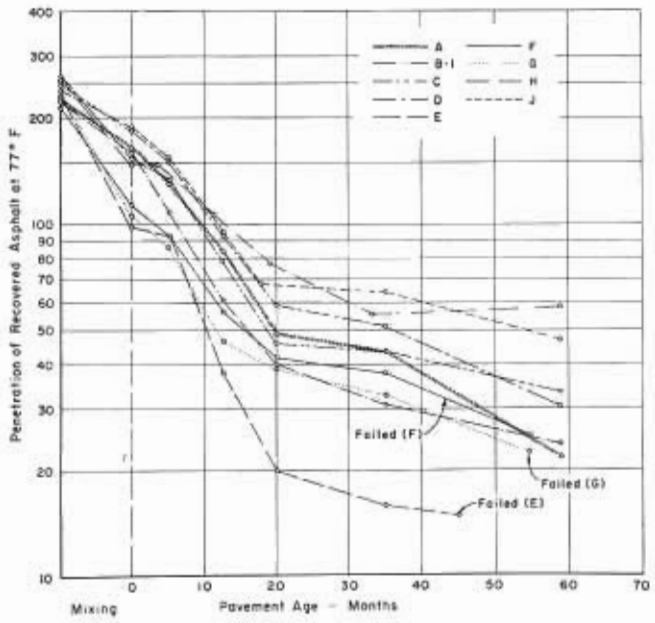
Our research studies indicated that certain asphalts produced from Mid-Continent crudes have superior durability characteristics when compared to California asphalts. In order to aid in the further evaluation of test methods under development, it was decided to obtain one railroad car of 40 tons from a producer using an Arkansas crude.

The project as finally constructed, is shown in Fig. 2. It contains six asphalts complying with the then new special provisions (frequently referred to as "Premium" specifications), two asphalts complying with the requirements of Section 54 of the 1954 Standard Specifications and two asphalts not commercially available in California at the present time, but placed in order to aid in the evaluation of new test procedures. The asphalts used on all portions outside the limits of the test sections consisted of either asphalt F or a mixture of the various asphalts on hand. The following table lists the asphalts and specification designations.

State of California Code Construction Period			*Specifications*
I	*IA*	*II*	
Asphalts Used			
A	--	A-2	Special Provisions
	B-1	B-2	"
D	--	D-2	"
F	--	--	"
G	--	G-2	"
H	--	H-2	"
C	C-1	C-2	1954 Standard Specifications
E	--	E-2	"
--	--	I-2(5.8)	Special
		I-2(6.3)	
J	--	"	"

Fig. 4

Fig. 3



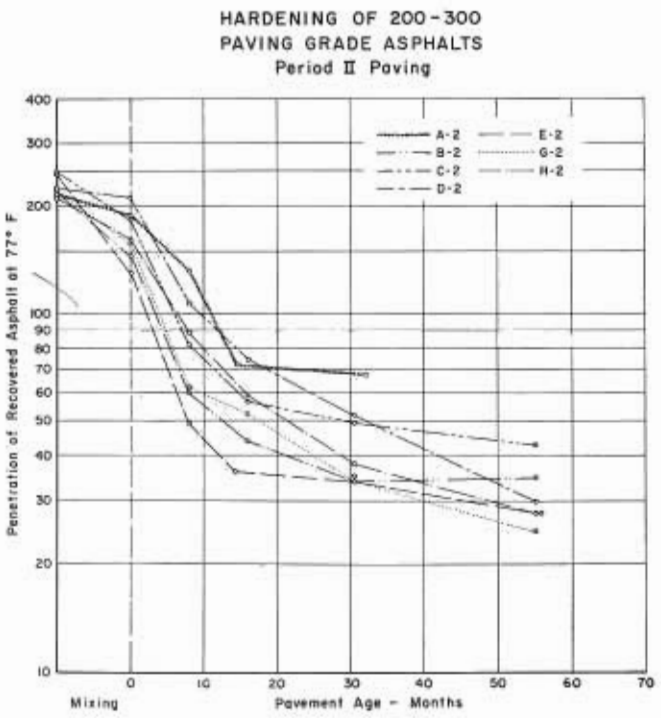


Fig. 5

ABRASION LOSS CURVES
FOR RECOVERED ASPHALTS
Period I and IA Paving

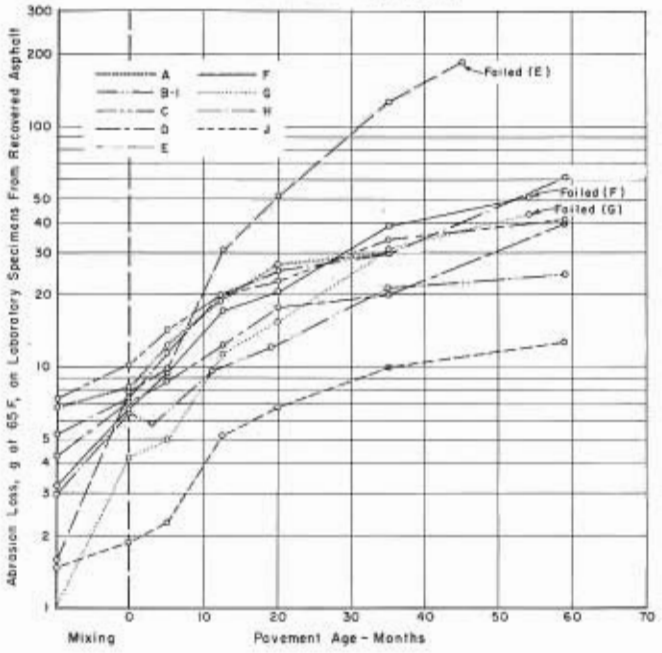
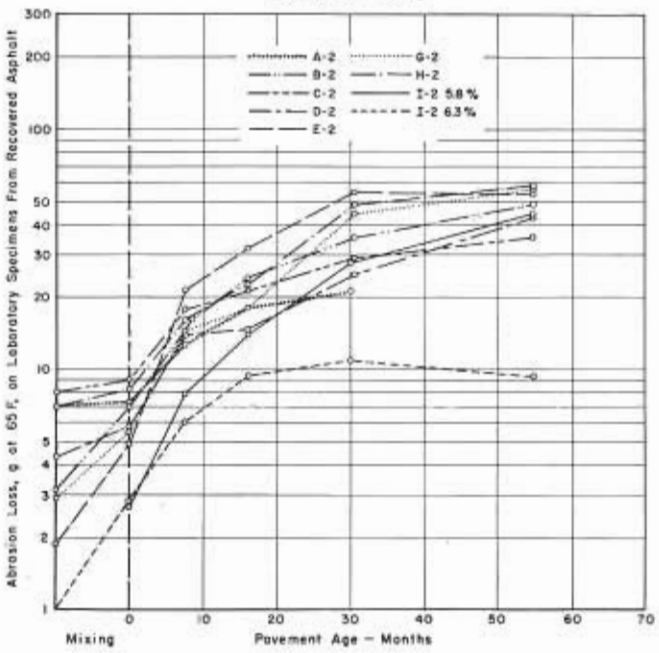


Fig. 6

ABRASION LOSS CURVES
FOR RECOVERED ASPHALTS
Period II Paving



Construction Operations

Construction operations on this project were somewhat complicated by the necessity of carrying traffic through the job site. After completion of subbase and cement treated base operations over the major portion of the new alignment paving began in October 1954 and was completed in November. This portion of the paving is designated as Period I. The remainder of the new alignment was paved in December and is called Period IA. Following completion of the new alignment, work began on the existing pavement and paving operations were performed in February and March 1955. This portion of Construction is designated as Period II.

The pavement throughout this project consisted of 0.33′ of plant mixed surfacing (asphaltic concrete) Type B placed in two lifts and conformed to the requirements of Section 20 of the 1954 Standard Specifications.

The aggregate source was a streambed deposit on the Santa Ynez River about ten miles from the job site. Processing was done in a portable crushing and screening plant.

TABLE IV

Average Deflection Readings in 0.001" With 15,000 lbs. Axle Load, for Asphalt Test Sections
Period I and IA Paving Over New Alignment — Period II Paving Over Existing Alignment

Paving Period	Average Deflection Outer Wheel Track-Travel Lane								
	April 1955	Dec. 1955	May 1956	March 1957	Nov. 1957	April 1958	Nov. 1958	April 1959	April 1960
Age-Mo.	5	13	18	28	36	41	48	53	65
I	12	12	10	10	9	17	13	16	19
Age-Mo.	4	12	17	27	35	40	47	52	64
IA	19	15	12	13	9	17	13	18	17
Age-Mo.	1	9	14	24	--	--	--	49	61
II	14	11	7	6	--	--	--	10	11

The paving mixture was prepared in a standard plant with aggregate temperatures maintained at 290°F. An asphalt content of 5.5% by dry weight of aggregate was used during Periods I and IA and 5.8% during Period II. Due to the variety of asphalts used, four separate tanks were provided for asphalt storage. The complexity of paving operations can well be imagined with as many as five changes in asphalt sources in a working day.

The level course was laid with a spreader box and blade. The surface course was placed with a self-propelled mechanical paver. Rolling of the level course was performed with a pneumatic and tandem roller, the surface course was compacted with a 10 ton steel tired tandem.

Average laboratory test results on field samples of the paving mixture for the various paving periods, are shown in Table I. Of interest is the finding that the specific gravities of laboratory compacted samples were consistently higher during Period II operations when compared to Period I and IA which is undoubtedly due to the increase in asphalt content.

All of the pavement was fog sealed at the end of Period II paving operations and traffic was routed over all lanes on March 30, 1955.

Performance Evaluation

Since opening to traffic periodic inspections for visually rating the service behavior of the respective test sections have been made by members of the Materials and Research Department, as well as detailed field and laboratory investigations. The following topics will be presented at this time.

1. Properties of pavement cores removed at various time intervals.
2. Changes in the original properties of the various asphalts recovered from the cores by means of the Abson Process.
3. Deflection studies.
4. Surface surveys and crack mapping.
5. Distress which has occurred up to date in certain sections.

1. Physical Properties of Pavement Cores

The physical properties of pavement cores up to 59 months service life are shown in Table II.

Although Period II paving was performed at lower ambient temperatures, it appears that the additional 0.3% asphalt in the mix permitted better compaction. The lower void content of the compacted mixture and heavier film thickness provided by the additional asphalt in Period II paving should lead to a lower rate of weathering.

2. Changes in the Original Properties of the Various Asphalts

Seven refineries furnished asphalt complying with the 1954 Special Provisions specifications, (which were somewhat different from our present 1960 Standard Specifications) and two additional sources furnished asphalt, complying with the 1954 California Standard Specifications. Specifications are shown in Table III. Asphalt I-2 did not have any specified requirements.

It will be noted that the drop in penetration, shown in Fig. 3 and 4 definitely indicates that less hardening occurred during mixing in Period II than in Period I for all of the asphalts.

The change in penetration and abrasion loss [2] for approximately 4½ to 5 years of service life are shown in Fig. 3, 4, 5 and 6. The curves showing drop in penetration, provide the normally expected shape, with a rather rapid increase in hardening during the first 16 to 20 months and a tendency to decrease thereafter. It is important to note that the slopes of the curves beyond the 16-20 month breakpoint must be confirmed by additional tests. If such slopes tend to remain parallel for the different asphalts, then the hardness of the material at the 16-20 month breakpoint becomes a fundamental criteria for asphalt durability, since the ashpalt having the highest retained penetration at this point should have the longest future service life.

It is interesting to note that extensive failures have occurred in the F, G and E Period I sections. It appears that a combination of drop in penetration into the 20-30 range coupled with a marked drop in ductility and gain in abrasion loss may signify serious paving failures when moderately

Fig. 7

CHANGE IN PENETRATION AND ABRASION LOSS FOR ASPHALT I-2

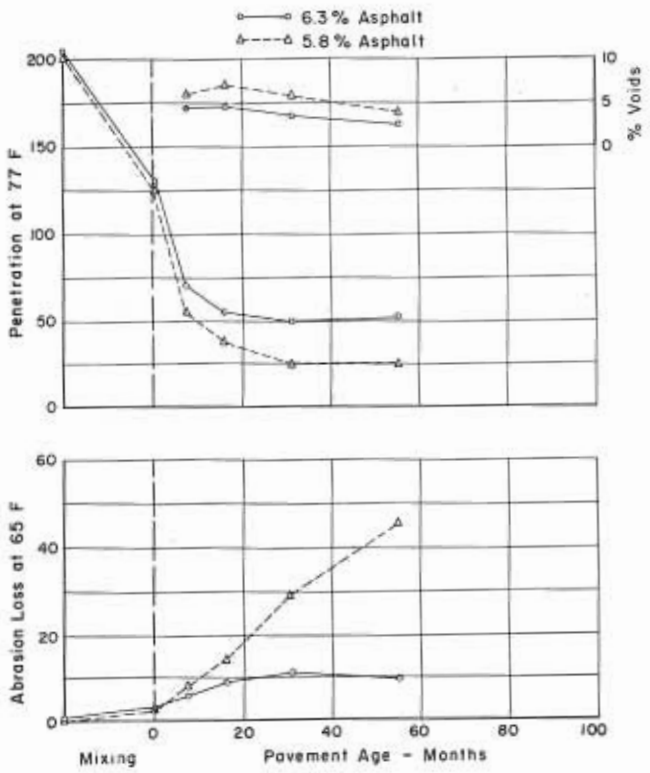
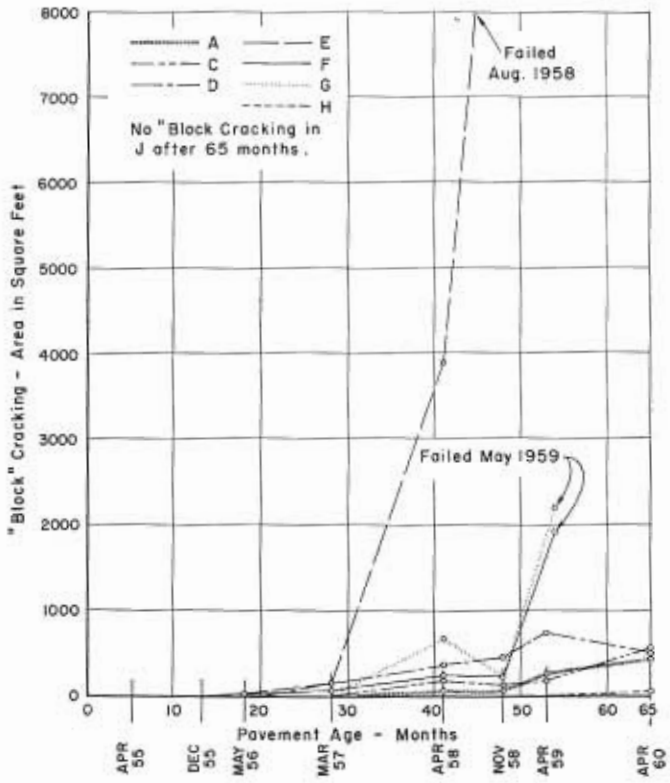


Fig. 8

"BLOCK" CRACKING IN ASPHALT TEST SECTIONS OVER NEW ALIGNMENT



high pavement deflections are encountered.

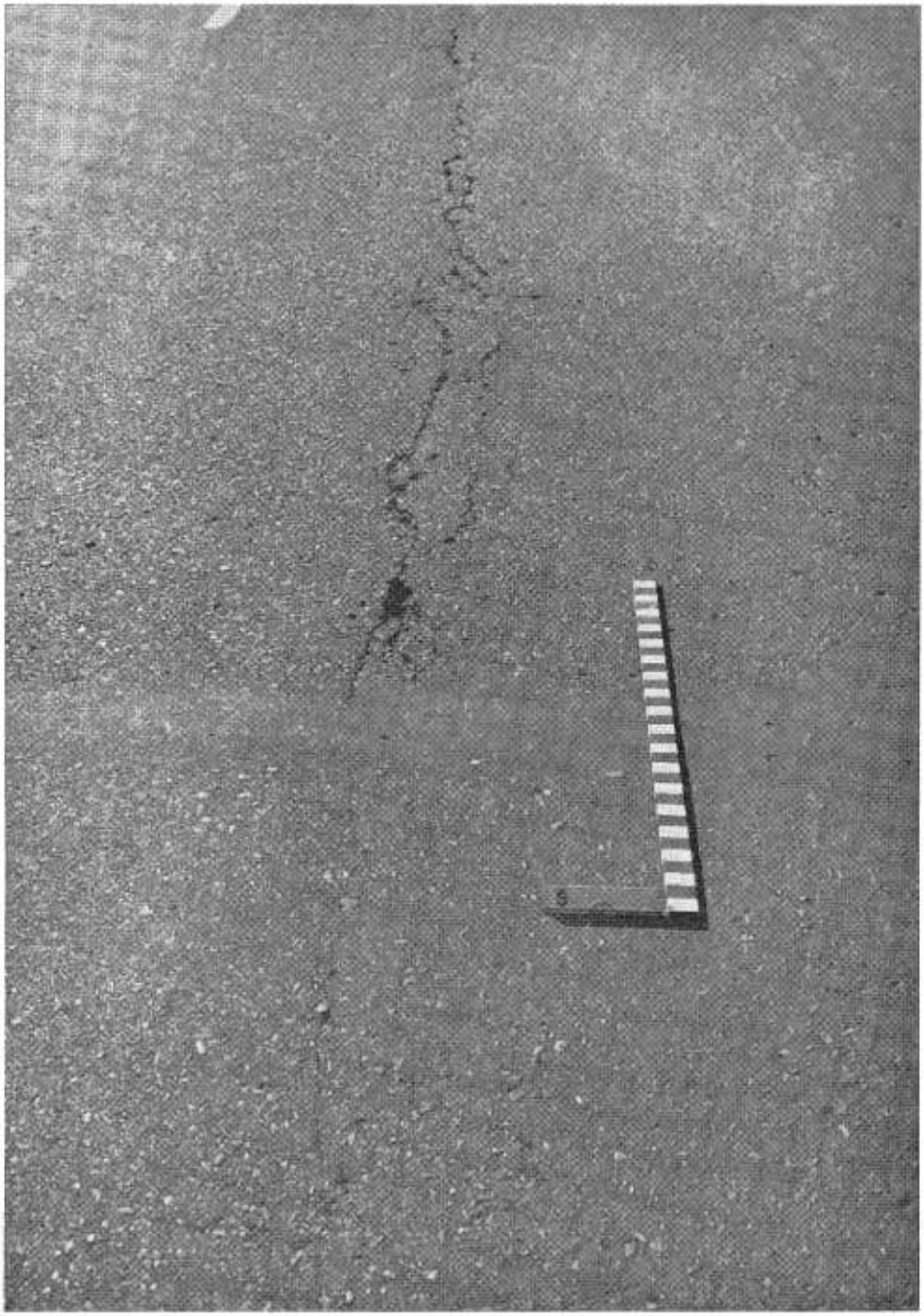
In the case of asphalt I-2, two asphalt contents 5.8% and 6.3% were used for adjacent test sections. The difference in asphalt content did not appear to be reflected in either the penetration drop or abrasion loss gain during mixing, but has produced a quite radical difference during pavement service life, see Fig. 7. These results confirm other reported findings that the weathering rate is affected by film thickness.

3. Deflection Studies

The average deflections for all paving periods, taken in the outer wheel track of the travel lane, are shown in Table IV. Deflection readings were also taken in the inner wheel track and the passing lane, but as literally thousands of measurements were taken, only the outer wheel track data are shown. This area of the pavement is generally considered the most critical one and the most indicative of the adequacy of the structural section.

In all periods there has been a gradual decrease in deflections up to approximately November 1957, or three years after construction. Apparently, consolidation of the various layers, has led to this decrease.

Following the readings in November 1957, the trend in deflections on the new alignment was definitely reversed. The spring readings following the severe wet winter of 57-58 showed a marked increase.



The junction between Asphalts D (foreground) and E (background) after 45 months of service life. Note spalling along longitudinal crack in the E section.

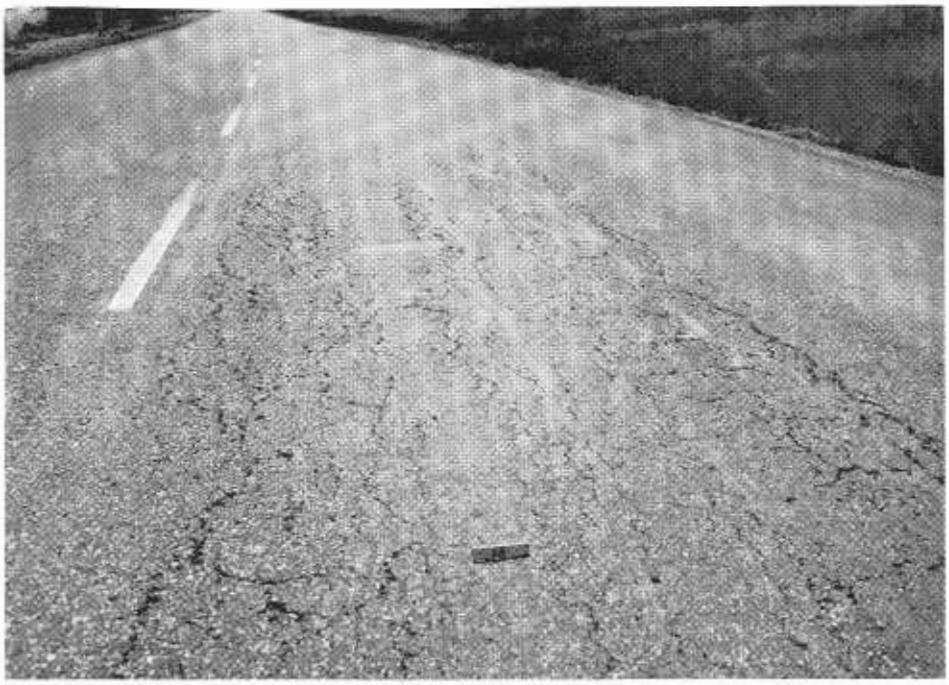
4. Surfacing Rating Surveys and Crack Records

The evaluation of service performance of the various test sections has been based not only on the results of tests on cores removed at various intervals, but also on visual observations and crack surveys.

About one year after completion of construction the surface of the pavement laid during Periods I and IA began to appear lighter in color and dry in appearance. The only section that did not show this early change in appearance was asphalt J. The lighter appearance of the surface is undoubtedly due to the nature of the aggregate. Many of the particles are light in color and the asphalt tends to wear off the surface thus providing an appearance of dryness. Actually, cores that have this surface appearance are quite black just below the surface.

One very significant index of pavement performance on this or any other roadway is the appearance of "block" cracking which invariably leads to major maintenance operations. The pavement laid over new alignment shows considerable block cracking, Fig. 8. This form of cracking is virtually nonexistent over old alignment after 65 months of service life and this is to be expected because of the extremely heavy structural section which results in quite low average deflections.

Of great interest is the excellent correlation between the definite increase in "block" cracking of the travel lanes in a number of sections and the marked increase in average deflection in April 1958. This "block"



Typical condition of the major portion of the Asphalt E travel lane is shown here after 45 months of service life.

cracking coupled with severe raveling has led to total failure in sections E, F and G. We note that the passing lanes are virtually free from "block" cracking. This, of course, is consistent with the pattern observed in our many previous investigations of this type of failure on other highways.

5. Failures

Three test sections over the new alignment, paved during Period I operations, have been classified as failures and now require major maintenance.

The first section to show extreme distress was that paved with asphalt E. The very rapid hardening of this asphalt caused a very marked increase in "block" cracking between 28 and 41 months of service life followed by an extremely rapid increase in the following four months, Fig. 8, 9 and 10. The situation in August 1958 became so serious that it was necessary to place a slurry seal over the travel lane in order to carry the section through the winter of 58-59. It is apparent from a study of the "block" cracked areas in the G and F test sections, Fig. 8, that the E section could have been classed as a failure approximately three years after construction or about October 1957. At this time the test properties of the asphalt were: Penetration =16, softening point = 151°F, ductility = 16 cm. and Abrasion loss at 65°F = 128 gms.

The G and F sections were classified as failed in May 1959. During the fall of 1958 the G section appeared very dry and exhibited a fair amount of raveling. The F section was in quite good condition except for severe longitudinal cracking in one fill area approximately 500′ in length. The next survey, in February 1959, revealed a striking difference from the Fall appearance. There was extensive "block" cracking in the travel lane throughout both sections and severe raveling extending into the passing lane. There was not as much evidence of spalling as found during the stages of progressive failure in the E section. Failure investigations were performed in May 1959 and the results are shown in Table V.

The proposed maintenance of the three sections involved the placing of a screening seal coat. However, it should be stressed that if the failure in any one of these sections would have occurred on a normal roadway, it would be necessary to lay a 2″ to 3″ thick asphalt concrete blanket in order to provide a proper wearing surface. The present seal coat program is only a temporary expedient in order to permit continued observations of the remaining test sections.

CONCLUSIONS

The various asphalts, placed in the test sections, are weathering at different rates, but all show a tendency toward a definite decrease in the rate of developing hardness or brittleness beginning after approximately 16 to 20 months of service life.

However, due to the two different construction periods, somewhat different structural sections, accompanied by other unavoidable variations it is strongly recommended that the asphalts laid in Period I be distinguished from those laid in Period II. In other words, we should consider that we have two separate test roads and comparisons between test sections should only be made within each test road.

The performance of the Zaca-Wigmore test road, to date, clearly shows that asphalts manufactured from different crude sources and methods of production can have various degrees of durability under equivalent conditions of traffic and climate. The early failure of asphalt E, which just barely met our 1954 Standard Specifications and would fall far short of our present

TABLE V

Recovered Asphalt Properties from Failed Test Sections Laid Over New Alignment

Asphalt	Age Mo.	Penetration 77°F	Softening Point	Ductility 77°F	Abrasion Loss-65°F
E	45	10	161	5	182.4
F	54	25	144	Very erratic Ave. = 48 Range = 7-83 on 9 cores	51.9
G	54	23	154	8	42.7

requirements, confirms other evidence that the previous Standard Specifications permitted the use of asphalts of poor durability with a comparatively short service life. The failure in the G and F test sections and other recent failures of asphalt roads in our highway system indicates that even our present specification requirements are still not sufficiently restrictive to guarantee a durable product. Obviously it will be necessary to continue to make laboratory and field studies with the objective of developing test methods and specifications which will effectively exclude non-durable asphalts.

Acknowledgments

A project of this magnitude requires the cooperation of many individuals, and it is not possible to mention all of the personnel of the California Division of Highways and of organizations that contributed to the successful completion of the test road, and the continuing studies on performance during its service life.

The work was performed under the general direction of F. N. Hveem, Materials and Research Engineer. The writer wishes to especially acknowledge the efforts of Mr. John Skog in collecting and analyzing much of the data.

Reference

(1) "Progress Report on the Zaca-Wigmore Experimental Asphalt Test Project" by F. N. Hveem, Ernest Zube and J. Skog. California Division of Highways. Presented at the Third Pacific Area National Meeting of ASTM, San Francisco, October 11-16, 1959. Symposium on Road and Paving Materials. ASTM Publication No. 277.

(2) "The Operation, Control and Application of the Infrared Weathering Machine—California Design" by John B. Skog, California Division of Highways. Presented at the Second Pacific Area National Meeting of ASTM, Los Angeles, September 17, 1956. ASTM Publication No. 212.

Bids have been received by the State Division of Highways on the resurfacing of 7½ miles of State Sign Route 89 in Mono County between the Alpine County line and U.S. 395. Low Bidder was the Thomas Construction Company, Fresno, $313,313.

L. D. Wanee Plans August 1 Retirement

Lessley D. Wanee, Assistant Construction Engineer for the California Division of Highways, will retire on August 1 after 32 years of State service.

Lessley D. Wanee

Wanee joined the Division in 1929 as a Senior Engineering Aid in San Bernardino. All of his subsequent service until 1955 was in the San Bernardino area where he advanced through the engineering ranks, being appointed design engineer of District VIII in 1947. He supervised the designing of the City Creek Road reconstruction in the San Bernardino Mountains, the first freeways in San Bernardino and Riverside Counties and the three-level U.S. 99-395 traffic interchange south of the City of San Bernardino. He was promoted to his present post and transferred to Sacramento in 1955. In addition to field review of highway construction in various parts of the state, he has been active in the revision of the Division's Standard Specifications.

A native of Denver, Colorado, Wanee attended public schools in San Pedro. He studied for two years at the University of California at Los Angeles, transferring to the Berkeley campus where he received his engineering degree in 1929. He is a member of the honor society, Chi Epsilon.

An ardent tennis player Wanee was senior singles champion of Arizona four times, senior doubles champion twice and has won more than 40 tennis trophies in tournament play. Wanee and his wife, Alice, were mixed doubles champions of Sacramento City in 1959. Mrs. Wanee is past Sacramento City and County champion.

Wanee is a member of the American Society of Civil Engineers, the Sutter Lawn Tennis Club and the South Hills Racquet Club.

Following his retirement Wanee will live in Vista, California, where he will do engineering consulting work and raise avocados.

Retirements From Department Listed

Headquarters Office

Rodney F. Reynolds, Supervising Engineer, 42 years.

District III

Harry H. Sharp, skilled laborer, 27 years.

District IV

Charles M. Barnes, Highway Foreman, 35 years; Stephen V. Gelter, Assistant Highway Engineer, 7 years.

District V

John G. Kehrer, Highway Equipment Operator-Laborer, 36 years.

District VI

Oliver F. Keough, Highway Equipment Operator-Laborer, 18 years.

District XI

James B. Elliott, Highway Equipment Operator-Laborer, 30 years.

Shop 8

Roy Cravens, Automobile Mechanic, 18 years.

IN MEMORIAM

District IV

George Phillips, Highway Engineering Technician I.

District VIII

Ernest L. Walker, Laborer.

Bridge Department

John E. Burke, Associate Bridge Engineer.

State-Owned Toll Bridges

Lonnell D. Smith, Toll Collector.

Shop 4

Dale Leake, Heavy Equipment Mechanic.

Bids have been received by the Division of Highways on the realignment of Pescadero Road between U.S. 101 and Pescadero Creek in San Mateo County. Low bidder was Bragato Paving Company and Bellshore Corporation, Belmont, $199,521.

Geer Road

New F.A.S. Bridge Cuts Travel Distance 4½ Miles

By ELLIS R. DELBON, Road Commissioner, Stanislaus County

In October, 1960, the Stanislaus County Board of Supervisors accepted the largest highway improvement project ever undertaken by the County.

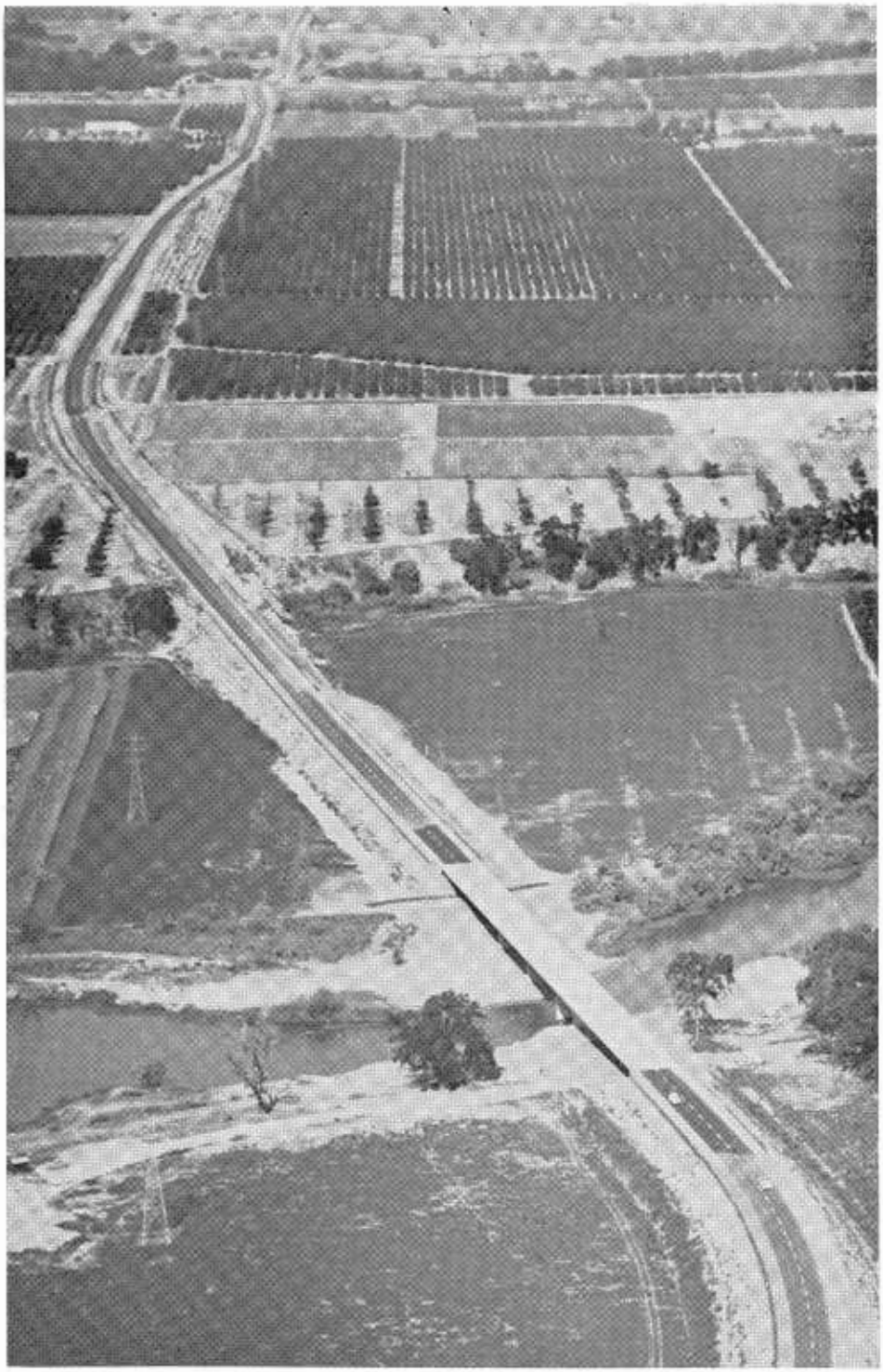
Opening of the new Geer Road Bridge over Tuolumne River was attended by many local dignitaries and representatives of the Division of Highways. The bridge is a portion of 2.1 miles of construction on entirely new alignment on FAS Route 914, which reduces travel distance between Turlock and Oakdale by 4.5 miles. It is the 10th major highway improvement project completed under the current 10-year capital improvement program approved by Stanislaus County Board of Supervisors in 1957.

Construction plans for this high standard two-lane highway were prepared by Stanislaus County with the contract being let late in 1959 by the State Department of Public Works under the Federal-aid Secondary Highway Program. Construction engineering and inspection was by County personnel.

Roadway construction involved grading and paving 1.96 miles. The road is surfaced with asphaltic concrete providing two 12-foot lanes and 8-foot paved shoulders. The Tuolumne River Bridge is a reinforced concrete box girder structure. It is 656 feet long, consisting of five 100-foot spans and two end spans 75 feet long supported on concrete piers and abutments on concrete piles. The clear roadway width is 28 feet between curbs and steel railings.

The total construction cost of the project is $513,000, not including preliminary engineering and right-of-way.

The County's capital improvement schedule includes improvement of five FAS routes and other County primary roads and bridges. The program is financed by appropriations from the County $5,000,000 bond fund approved in 1956, State Highway Users Tax Funds, and FAS Funds.



Geer Road in Stanislaus County between Turlock and Oakdale which was recently constructed under the Federal-aid Secondary and County Bond Program. The bridge in the foreground is over the Tuolumne River. (Modesto Bee photo)

California Roadsides—3

EDITOR'S NOTE: This, the third in a series of articles on landscaping and related roadside problems on the California State Highway System, covers the maintenance of landscaping and roadsides under today's policy and practices. The next and final article will cover the plants used today by the Division of Highways Landscaping Section, and why these choices have been made. The four articles will be made available to interested persons as a reprint booklet under single cover.

The series has been prepared by John Robinson of the Public Information Section with the assistance of various staff members concerned with planning, planting, and maintenance of roadsides.

It has been shown how the earliest road maintenance problems were those of mud and dust, and that the roadside tree was helpful in controlling these problems. Later, with straighter roads and modern design, slope control also became a problem. With the gradual refinement of the automobile as our main means of transportation, many new maintenance problems have developed. Here are some of these modern developments which have complicated roadside maintenance.

Today's cars are faster, longer and lower. This kind of automobile requires a different kind of highway from the one used by the famous Model-A Ford with its high clearance, good visibility, and short wheelbase. A driver of today's car is unable to see over slight rolls in the terrain, and his speed demands more sight distance on curves for safety. Nor can he easily negotiate sharp curves even if he can see around them, because of his car's speed, weight, and long wheelbase.

To a great degree, therefore, today's highways are dictated by automotive design engineers in Detroit. To be safe for today's vehicles, highways must be broad, with gentle, wide-sweeping curves. Rises must be cut down, and dips brought up to grade, so today's low seated driver can see far ahead. This kind of highway goes *through* the terrain instead of following land contours as the stagecoach roads did. Obviously, there must be more cuts and fills than ever. These countless new slopes create new problems of settlement, slippage, and disturbance of esthetic values. It is necessary, too, that obstructions such as bridges and interchanges on these new high speed highways be clearly delineated.

Smokers are another problem. Highways today must be considered a fire menace to every dry field and forest they border, for although it is against both common sense and the law, every day thousands of smokers carelessly throw lighted cigarettes and matches from cars. This is a more difficult problem than the spark problem of the early day railroads, which was solved by screens over the stacks of the locomotives.

Another relatively new maintenance job is the care of headlight screen planting in the median. With today's high speed vehicles bright headlights are needed, which in turn blind the drivers of oncoming vehicles. The best solution to this problem so far devised is the erection of some obstruction between the opposing lanes of traffic. On most highways in California the cheapest and most decorative solution is a living barrier of shrubs.

Then there is litterbugging—not exactly a new problem, but today many times magnified over what it was a generation ago, primarily because our technology has developed marvelous packaging of our foods, tobacco products, and beverages. Unfortunately, this packaging is usually partly or entirely of paper (except in the cases of beverages, when it is tin, glass, or waxed cardboard). Furthermore, everybody is constantly deluged with newspapers, magazines, direct mail advertising, and dozens of other kinds of printed matter. Most of these things are of temporary value, and are too frequently disposed of on the highway, although this too is illegal.

As previously pointed out, the judicious use of plants and landscaping techniques can assist the highway engineer in solving, or at least alleviating, these and other problem conditions. But the planting itself is only the first step. When the landscape contractor has finished his job, the maintenance man starts in. And as with many other expenditures, both public and personal, "it isn't the initial cost, it's the upkeep".

"ROADSIDE MAINTENANCE IN STANISLAUS COUNTY IN 1895"

"It is the custom to cover the roads in the summer season with refuse straw, which is abundant. This the most temporary makeshift. The cost of this strawing varies from $40 to $45 per mile, and in many instances must be repeated two or three times a season. Nor is this all. It frequently happens that a lighted match or cigar is dropped on a freshly strawed road, and the whole roadway vanishes in smoke. It is a well-authenticated fact that, on one occasion on the day after a road had been strawed, a band of hungry cattle came along and actually ate the road up."—From the 1895-96 Report of the California Bureau of Highways.

These are some of the activities and considerations involved in roadside planting maintenance:

- **Median plantings:** As previously stated, the Division of Highways landscape architects are in unanimous agreement that the most practical shrub for median planting for headlight screening is the oleander. But despite its hardiness, it must be watered for several years after planting;

it must be pruned in locations where it affects sight distances; litter must be cleaned from around it; and it occasionally must be replaced after an accident.

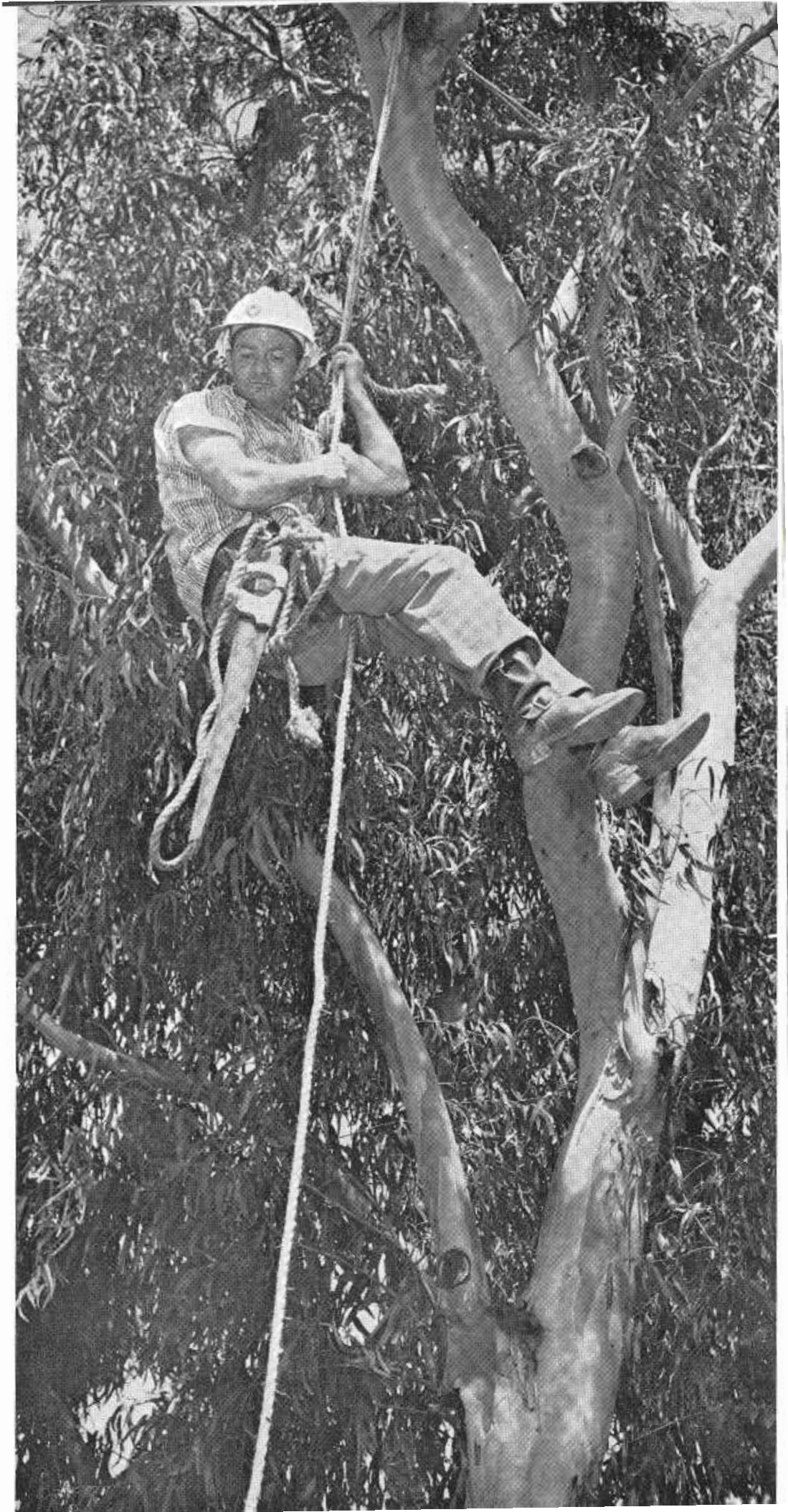
● **Delineation:** Trees are planted to mark structures which might not otherwise be noted by a fast moving motorist. Shrubs or trees accentuate a curve, and a ground cover emphasizes a traffic island or "gore" between the main route and the off ramp. All these plantings mean additional maintenance.

● **Erosion control:** Wherever any of the slope stabilization methods are used, the plants must be fed, watered, and weeded for several years until they are established. Some must be watered indefinitely. The contractor's responsibility for plant establishment on landscaping contracts usually ends after 90 days.

● **Fire control:** Because of careless smokers, "fire control" is necessary on thousands of miles of state highway, to protect such flammable areas as forest, grassland, and grainfields. This is another problem which does not trouble states with adequate year-around rainfall.

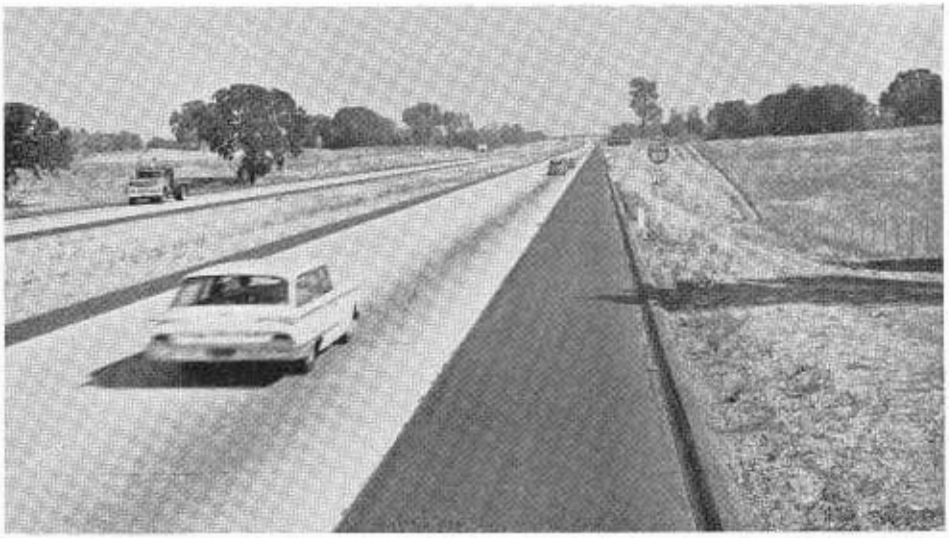
In most of California's rural areas today, fire control simply means removal of all vegetation from a four-foot strip outside the shoulder on either side of the road. Sometimes this is accomplished by discing or grading, but it is most likely to be done by chemical weed killers and sterilants. The sterilants are faster, neater, and leave no blackened roadside. Thirty years ago fire control was accomplished by spraying diesel oil on the roadsides; then, a week or two later, burning a ten-foot strip beyond the shoulder. Today's four-foot strip has proved adequate, and presents little bare area for soil erosion to start.

Where they can be used, evergreen ground covers are excellent fire controls. Unfortunately, because of the summer drought, it is impracticable to attempt to grow ground covers along highways throughout most of the state, since there are no satisfactory



RUFUS J. W. COX demonstrates safety line technique taught Division of Highways tree maintenance crews.

Section of U.S. 40 (Interstate 80) in the Sierra Nevada showing dike and cleared area outside it. Dike is essentially for control of runoff water, but also catches many cigarette butts.



Neatly trimmed section of U.S. 40 near Roseville blends into surrounding landscape.

Dense growth of drought resistant plants on U.S. 101 in San Luis Obispo serves to delineate turnoffs, to lessen fire hazard, to keep down weeds, to screen and to beautify.

ground covers which can survive any length of time without water. The mesembryanthemums, or ice plants, have proved practical in certain cool coastal sections where fog is common. Where conditions are good for them, they are almost ideal plants for slope control, fire control, and pleasant effect. Certain ivies are also effective, but they must have sprinkler systems installed for their survival.

All ground covers need some maintenance. The ice plant needs the least, but occasionally should be fertilized, and must be weeded assiduously until it is established (as must all plantings).

● **Roadside growth:** In recognition of the farmer's troubles with noxious weeds, the State Department of Agriculture has long been empowered to organize control methods to keep these expensive pests in check. There are several dozen species of weeds on the state's list which are potentially dangerous. By decision of the County Agricultural Commissioner, any of them can be declared a noxious weed in any county.

The Division of Highways cooperates on county programs, for noxious weed control. In most cases, where the infestation is serious, payment is made from highway funds to the county, to pay the expense of using specialists to control the pest on State highways. These payments amount to about $100,000 per year statewide. Where infestation is light, Division of Highways maintenance crews do routine weed control, most of it by mowing.

Whenever possible, weeds on the roadside are mowed early, before weeds go to seed, which gradually tends to reduce roadside growth to grasses only. Several more mowings are made during the season as necessary. Mowing reduces fire danger, and also makes a neater roadside. Roadside mowing costs have been significantly reduced in recent years, by the adoption of the modern rotary type mower.

Roadside brush, which would otherwise gradually encroach on the roadway, particularly in foothill and mountain areas, must be kept in check. Brushcutters which cut a swath from the roadside and chippers, ingesting

Where medians are wide and midday traffic is not too heavy, power equipment can be used for maintenance. John Musitelli trims median on El Camino Real south of San Francisco.

the cuttings and returning them to the roadside as finely chopped twigs and leaves, are very effective, but somewhat slow and expensive to operate. Chemicals are widely used today for brush control.

● **Roadside tree maintenance:** The California Division of Highways has tree maintenance crews throughout the state. These men are in a special group which includes such job classifications as Tree Maintenance Foreman, Tree Surgeon, and Tree Trimmer.

The thousands of miles of roadside in the state highway system have many old plantings of trees which must be maintained. Modern planting practice also calls for generous use of trees for delineation at ramps and bridges.

Dead limbs and unstable trees that are a hazard must be removed; so must low branches which obstruct vision and roadway clearances. Trees which are too high must be topped lest they blow over in a high wind. When the scope of any of these jobs is too great for routine maintenance, they can be let out to contract by professional tree care companies.

● **General planting maintenance:** Modern highway practice in California calls for roadside beautification wherever possible in densely settled areas. This may be accomplished to a limited extent with functional planting, or where suitable billboard control laws have been passed, by a full landscaping project. In either case, the planting will not only be roadside beautification, but will also function to absorb highway noises, gases and dust, prevent fire, delineate traffic changes and control erosion.

Landscaped roadsides must be maintained indefinitely. This kind of maintenance includes pruning, weed and pest control, fertilizing, and irrigating. Pruning is relatively light, usually necessary only when a change in conditions requires it, such as disease, dieback, or occasional unexpected growth to a size where foliage interferes with sight distances.

Weed control is very difficult on new jobs, but gradually lessens as the planted shrubs and ground covers take over. Weed killer sprays and oil sprays are used considerably to protect young shrubs and young trees. Because of the weed problem, highway landscape architects today especially favor shrubs which branch out right at the ground and grow in a dense globular shape, such as Lehman eucalyptus, dwarf blue eucalyptus, and oleander. This kind of plant is

ideal for screens, but unfortunately plants of this habit are not available for all of California's soils and climates.

Watering from a tank truck is expensive. This kind of watering is only done when sprinkler systems are impracticable. Usually, the tank truck is used only to water drought hardy plants the first couple of years they are in the ground, to give them a good start.

This kind of watering is also dangerous; several of the tank trucks have been badly damaged by out-of-control vehicles, but luckily none of the operators was injured seriously. (Landscape maintenance is a dangerous occupation. Workers are hit by flung beer cans and flying hub caps, catch poison oak, get bugs in eyes, are stung by bees, bitten by snakes and spiders, sometimes even by small rodents such as squirrels and muskrats. They also have their share of the more common industrial accidents.)

Where economically feasible, and generally on major freeway landscaping jobs, permanent sprinkling systems are installed. These not only irrigate, but also wash the foliage. The water costs are high, however, and limit this type of installation.

No way has yet been devised to eliminate what virtually amounts to hand labor in performing most of these chores of freeway landscaping maintenance. The many cuts and fills, with their steep slopes, the odd shaped pieces of land around interchanges, the difficulty of working close to heavy, fast-moving streams of traffic, all tend to limit the use of mechanized equipment for this work. Some of the new back-pack power units with cutter attachments are being looked at hopefully. However, over the years the most fruitful channels explored to help this problem have been experiment and search among the plants themselves.

In the course of regular operations, maintenance workers Johnnie Shephard, Robert Spencer, and Jack Warman, District IV, replace a plant which has died.

The Division of Highways landscape architects have learned that except where communities are willing to absorb part of the maintenance cost, landscaping today must be more and more restricted to certain tried and true "workhorse" shrubs, trees and ground covers, and that the thousands of varieties of beautiful but delicate ornamentals which quickly succumb at the slightest rough treatment must be avoided.

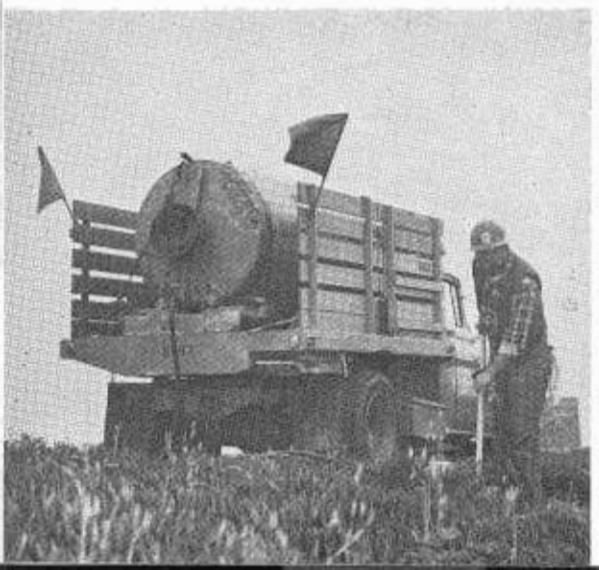
These "workhorse" plants are the ones which can exist with little or no water, ordinarily do not require fertilization, and are virtually pest-free, hardy, and adaptable. The list of such plants is short, but each year, out of the many tried, a few new ones for the list are proved.

Such limited plant choices have occasionally caused the Division of Highways to be criticized for "lack of imagination" in its use of plant materials, but the fact is the lack of variety springs from practical economic considerations, rather than lack of esthetic sensitivity.

The restriction of planting to these easily maintained plants, plus an energetic and conscientious educational program given the landscape workers by their supervisors, has paid off handsomely. Ten years ago, the table of organization called for one landscape laborer to maintain three acres of highway landscaping. Today he maintains seven acres.

● **The litterbug:** In urban areas, where there is a landscaped freeway, landscape maintenance men do considerable litter removal. Disposal cans are obviously impracticable on these highspeed, heavily traveled routes, although the heavy traffic generates tremendous amounts of litter. The difficulties of enforcing the anti-litterbug law are obvious. The litter cans the state now provides in rural areas are serviced by maintenance forces, and they are collecting great amounts of litter, but many motorists still refuse to use them. Conversely, where cans

While the watering basin around young plant is filling, Clyde Francis, Groundsman, District VII, cleans up weeds.



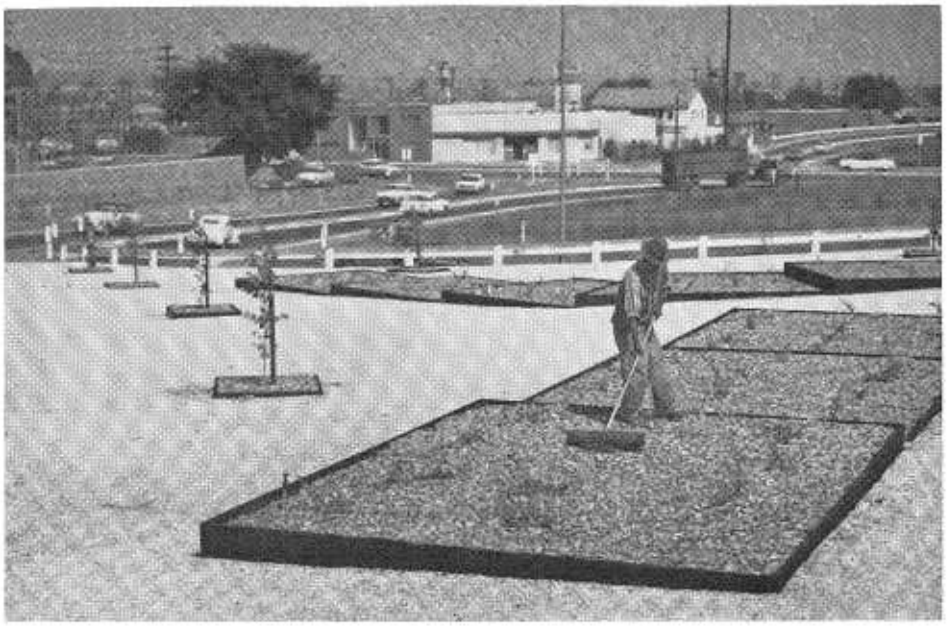
are close to communities, local people often use them for disposing of household garbage!

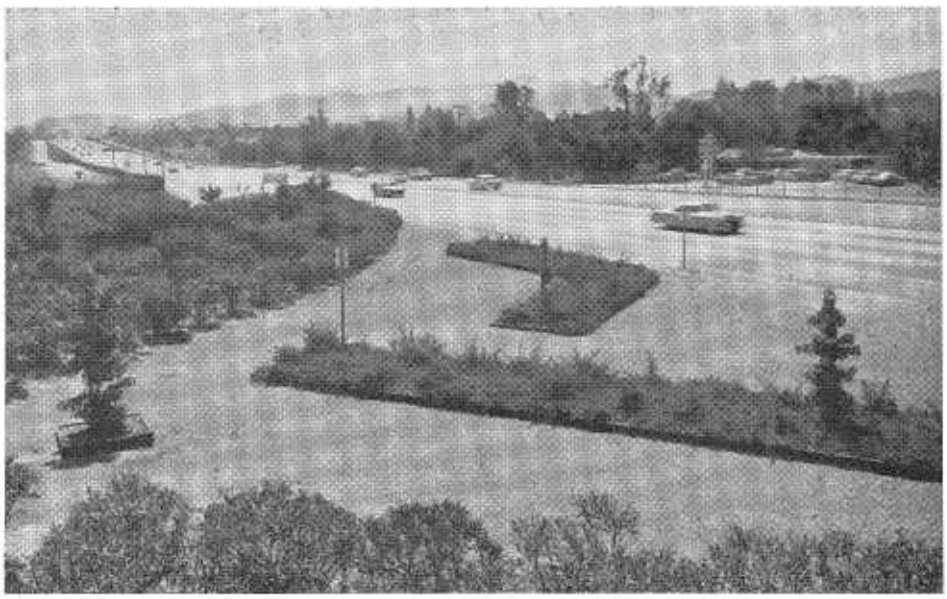
An intensive public education campaign, backed up by firm enforcement when possible, has been going on for some time. It must be assumed that those who continue to strew our highways with litter are an irresponsible minority whom no campaign will reach. Better clean-up equipment may be invented, but because of the nature of the work, this seems unlikely in the near future. It begins to appear that we must resign ourselves either to a heavy annual bill for litter removal, or be willing to accept dirty, unkempt roadsides.

All these things, from the median screen to litter, are over and above the job and the costs of removing snow, of repairing pavements, of replacing guard rails and signs, and those other tasks normally associated with highway maintenance. Aside from these unavoidable costs, maintenance of just the roadsides and of the trees, shrubbery, and ground covers on the right-of-way, whether it is functional planting or landscaping, increases in cost each year and is now approaching $5,000,000 annually. In addition, there is an annual bill for State highway litter cleanup in this state of about $1,250,000.

There seems to be no hope these costs will ever be less. In fact, we must expect them to be much more if we but consider that our present traffic loads will be doubled in about 20 to 25 years. Nor can we even expect that these costs will increase in simple ratio to traffic increase. Roadside maintenance costs on multilane divided highways are much higher than older-type two-lane roads because of medians, the large areas required for interchanges, larger cuts and fills, more structures, heavier traffic use, and wider right-of-way.

Expenditures for maintenance and administration of the State Highway System are limited to the revenue derived from one cent per gallon of the tax on gasoline and diesel fuel. With necessary expenditures approaching the legal limit, any further increase in landscape maintenance costs, which already constitute an appreciable portion of the total maintenance budget, requires very careful control and exercise of judgment for installations involving continued or more costly maintenance.





Above: Newly landscaped interchange on the Golden State Freeway in Los Angeles showing redwood planting boxes surrounded by gravel over sterilized soil. Original cost is less, and maintenance is minimized on large areas by this type of planting. Below: Older planting of same type on San Bernardino Freeway illustrates how this kind of landscaping delineates and beautifies.

(The next and final roadsides article will be concerned with the plants and trees used by the California Division of Highways, and why they have been chosen.)

The State Department of Public Works has awarded a $739,000 contract for construction of five miles of two-lane highway on State Sign Route 53 between Harris Creek and Lower Lake in Lake County.

The California Highway Commission at its May meeting allocated $250,000 as the State's share of 15 traffic signal, highway lighting and channelization projects located throughout the State.

Flood Problems - 2

State Helps on Guadalupe, Walnut Creek Projects

This is the second part of an article which appeared in the March-April issue.

GUADALUPE RIVER CO-OPERATIVE DRAINAGE PROJECT

By P. B. JANSEN, Associate Highway Engineer

A MAJOR co-operative project involving drainage is exemplified by the co-operative agreement between the Division of Highways and the Santa Clara County Flood Control District, providing for improvement of the channel of the Guadalupe River in conjunction with the project for conversion and expansion to full freeway standards of the Bayshore Highway, U.S. 101 Bypass, northwesterly of San Jose.

The Bayshore Highway, where it crosses the flood plain of the Guadalupe, was originally constructed about 1937 as a four lane highway with a narrow dividing strip. It is currently being reconstructed as a six-lane, ultimate eight-lane, freeway with a full width median.

The small channel of the Guadalupe River in this area has been historically inadequate to handle the flows resulting from major storms, hence flooding of the surrounding land has frequently occurred. At the time of original highway construction it was therefore necessary to bridge three historic overflow channels of the Guadalupe as well as the main channel. This unsatisfactory solution was the only one possible at that time and the highway has since been subjected to a number of inundations.

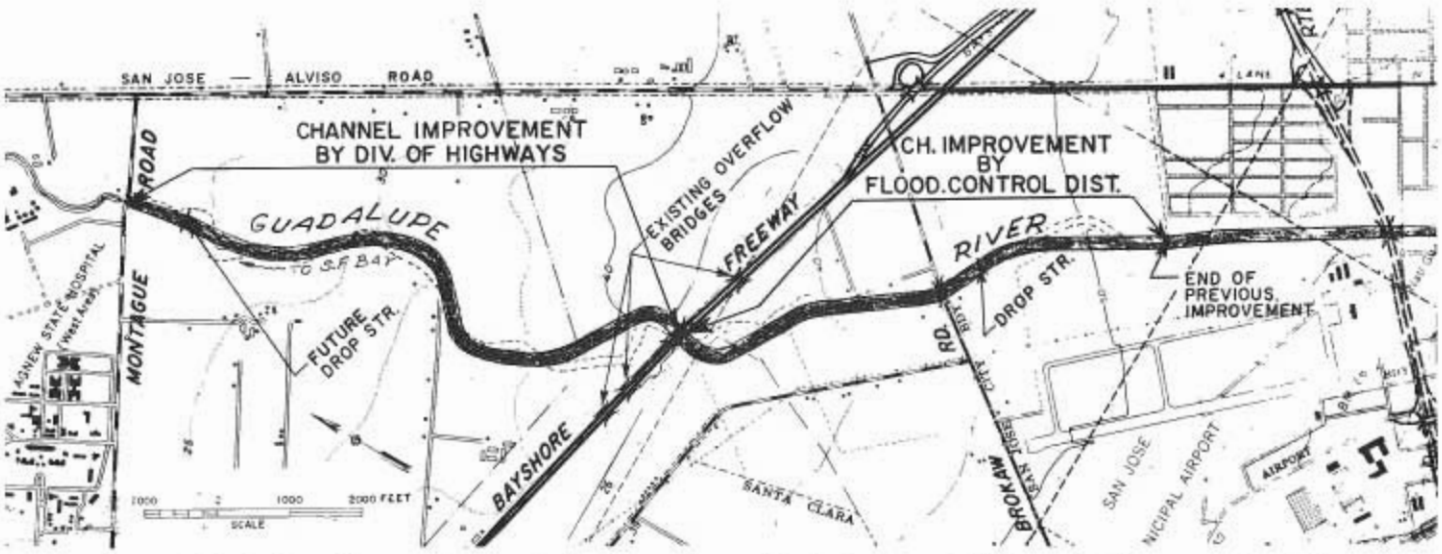
In planning the additional lanes of this highway facility it was recognized that unless channel improvement of the Guadalupe was undertaken prior to or concurrently with the highway project it would be mandatory to provide bridges for the additional lanes at the overflow channels as well as at the Guadalupe River.

Concurrent Studies

At the same time the City of San Jose and the Santa Clara County Flood Control District were conducting studies for channel improvement of the Guadalupe River, although it appeared unlikely that the flood control project could actually be undertaken until some time after completion of the freeway project. It was also realized that upon subsequent completion of the flood control project any money spent upon extension of the overflow bridges would have been wasted except for the relatively short period in which they would serve to retain the existing drainage conditions. It was further recognized that subsequent excavation of the channel improvement would yield large quantities of excess material which would probably present only a disposal problem, whereas integrated timing of the two projects would present an opportunity for economical use of the channel excavation in the highway embankment.

The reach of the Guadalupe influencing highway considerations extended from a point near Montague Road 8,000 feet north of the freeway crossing on the downstream side to a point 7,000 feet southeast of the freeway crossing on the upstream side. The latter point was the downstream terminus of a recent channel improvement project.

Had the necessary flood control works on the Guadalupe consisted of channel improvement only, no financial problem would have existed, since



A map of the Guadalupe River near San Jose showing the area improved by the drainage project discussed in the accompanying article.

the potential material from channel excavation could be economically utilized for the Bayshore Freeway and for the City of San Jose's Muncipal Airport, Guadalupe Parkway and De La Cruz Boulevard. The financial problem centered around acquisition of right of way for the channel improvement and the cost of expensive structures which were essential appurtenances to the channel improvement.

Channel Constriction

The existing bridge at Brokaw Road, which crosses the Guadalupe River about 4,000 feet upstream of the Bayshore Freeway, constituted a severe constriction in the channel and its replacement with one of adequate span comprised one necessary structure. Other necessary structures were imposed by the nature of the soil and the terrain. Although the terrain looks relatively flat, its general slope is steep enough so that if the improved channel were built on this slope, erosive velocities would be produced in the channel and through the Bayshore Freeway bridge.

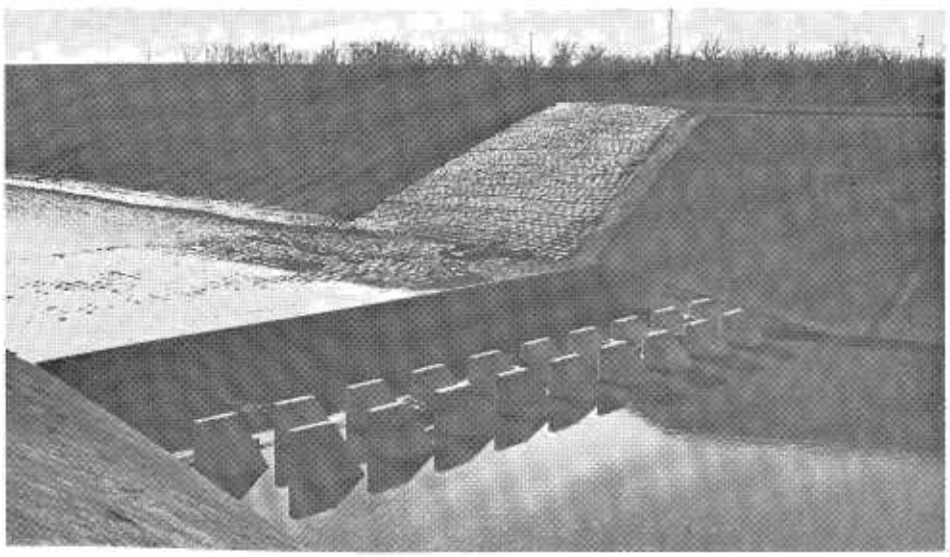
The solution most adaptable to this difficulty was the employment of drop structures. A drop structure is a concrete structure incorporated into a channel, the essential feature of which is a vertical drop, thus permitting the reaches of channel upstream and downstream of the drop to be constructed on a gradient more gentle than that of the surrounding land. It was decided that the most favorable sites for drop structures were at a point about 700 feet upstream of Brokaw Road and at another point about 800 feet upstream of Montague Road.

Since properly timed construction of the improved river channel and its appurtenant structures would relieve the Division of Highways of the necessity of constructing bridges for the additional lanes at the three overflow channels, it was reasoned that the State could justifiably contribute toward the cost of the flood control structures an amount not to exceed the cost of these overflow structures. This amount was estimated at $150,000.

In accordance with the above considerations a co-operative agreement was negotiated between the Santa Clara County Flood Control District

The Guadalupe River channel looking downstream from the Brokaw Road Bridge.

A view of the improved Guadalupe River channel at Brokaw Road Bridge.



A view of the drop structure in the river channel north of Brokaw Road.

and the State which essentially provides:

1. The Flood Control District is responsible for construction of the channel improvement upstream of Bayshore Freeway, for the construction of the drop structures and the Brokaw Road Bridge, for the acquisition of all right of way necessary for the channel improvement and the operation and maintenance of the channel.
2. The State shall construct the channel improvement downstream of Bayshore Freeway, all excess material remaining after backfilling of the old channel and construction of levees to become the property of the State. The State shall contribute 50% of the cost of the two drop structures and 20% of the cost of the Brokaw Road Bridge, but not to exceed a total contribution of $150,000.

The Bayshore Freeway, the channel excavations, the Brokaw Road Bridge and the drop structure near Brokaw Road are nearly completed. Financial benefits to the parties to the agreement can be estimated from the bid prices for these units and from the preliminary cost estimate of the drop structure near Montague Road which is to be deferred until the time of channel construction downstream from that point.

Maximum Amount Required

Since the cost of the structures will apparently be such as to require the maximum contribution of $150,000 from the State, financial benefits to the State will accrue from the use of channel excavation material in the roadway embankments instead of the more expensive imported borrow, which would otherwise have been required. The total cost of the State's portion of channel excavation is $501,000; the value of the material to be used in the roadway embankment, figured at the cost of imported borrow, is $642,000, resulting in a net savings in construction cost of $141,000.

Financial benefits to the Flood Control District consists of the $150,000 contribution of the State toward the cost of the structures, and the value of State's work in channel excavation, $501,000 as noted above, for a total benefit of $651,000.

In addition to the direct financial benefits, this co-operative agreement has made possible the early completion of flood control facilities through a significant portion of the flood plain of the Guadalupe River. The consequent elimination of the flood threat makes possible accelerated development of the surrounding lands. Several years' potential flooding and closure of Bayshore Freeway and other facilities, with resultant public inconvenience, danger and economic loss, has also been eliminated.

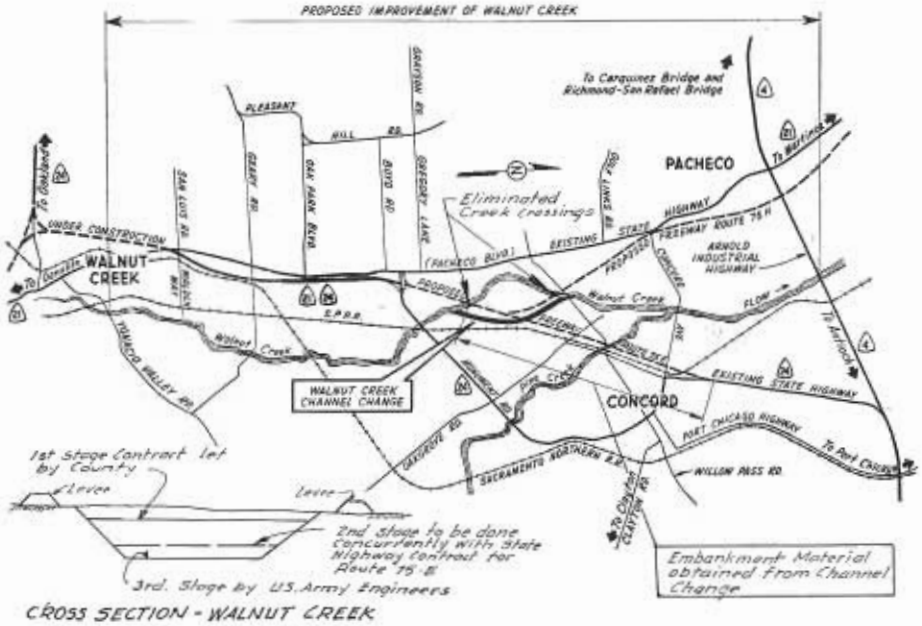
WALNUT CREEK CO-OPERATIVE AGREEMENT

By A. S. LAGSDIN, Associate Highway Engineer

Scarcity of embankment material for the construction of the proposed freeway in the Concord area led to a co-operative agreement between the State and local agencies for realigning Walnut Creek in Contra Costa County. In addition to providing embankment material, one creek crossing will be eliminated and a total saving of approximately $667,000 to the State will be realized. If embankment material were not available in this vicinity costly borrow sites involving long haul distances would be the only solution.

Approximately 5700 feet of Walnut Creek channel will be realigned and the approximate 600,000 cubic yards of borrow when obtained will be placed as embankment in the highway right of way from 0.6 miles north of Monument Road to north of Concord Avenue.

Walnut Creek and its tributaries have a long history of hydraulic inadequacy and flooding of surrounding areas has been frequent. With rapid urbanization and industrialization of the watershed, the flooding problem has become more acute from year to year resulting in greater flood damage costs and increased danger to life and limb. These conditions have prompted the County to embark upon a crash program to improve reaches of Walnut Creek where the deficiencies are the greatest.



A map of the Walnut Creek area showing the channel change discussed in this article.

Creek Capacity Increased

This work extends from Arnold Industrial Highway up to Ygnacio

Looking south at the completed first stage of channel relocation which will serve for flows in excess of 7,000 cubic feet per second.

Valley Road and will increase the creek capacity from approximately 7000 cubic feet per second to 11,000 cfs. This work will offer a reasonable degree of protection to private properties and portions of State highways for floods approximately the 1955 and 1958 magnitude in the Walnut Creek watershed area.

All work being done will fit into the creek improvement program to be done by the United States Army Engineers and designed to handle 18,000 cfs in the channel change reach. This is the estimated required capacity after full development of the watershed. The Army Engineers' work will extend from Suisun Bay through all reaches of Walnut Creek and a short portion of the downstream reaches of the tributaries: Grayson, Las Trampas and San Ramon Creeks.

The channel change being done under a co-operative agreement fits into the County's $672,000 program for improving drainage and will result in an overall saving of taxpayers' monies to the State and the County.

Originally it was planned to construct the channel change on a State-let contract concurrently with construction of Route 75-E; however, the County program made it necessary to proceed with the channel change as soon as possible on a separate contract.

The State agreed to this arrangement; however, the project appeared doomed when it was learned that the East Bay Municipal Utility District could not relocate their aqueducts, which cross the channel change, last year. This obstacle, however, was overcome by a plan wherein an overflow channel 3 feet to 5 feet deep with an average bottom width of 240 feet would be constructed along the same alignment as the channel change and fit into the ultimate channel section. This channel would act as a bypass for the present Walnut Creek channel in this area for runoff quantities in excess of 7000 cfs and would cross over the East Bay Municipal Utility District's lines. The old creek and the bypass will handle a combined drainage quantity of 11,000 cfs.

County Lets Contract

This work was done on a contract let by the County to the Ransome Company for $76,000 paid by the State. Had the County improved the creek along the old alignment the cost would have been $90,000 to the County.

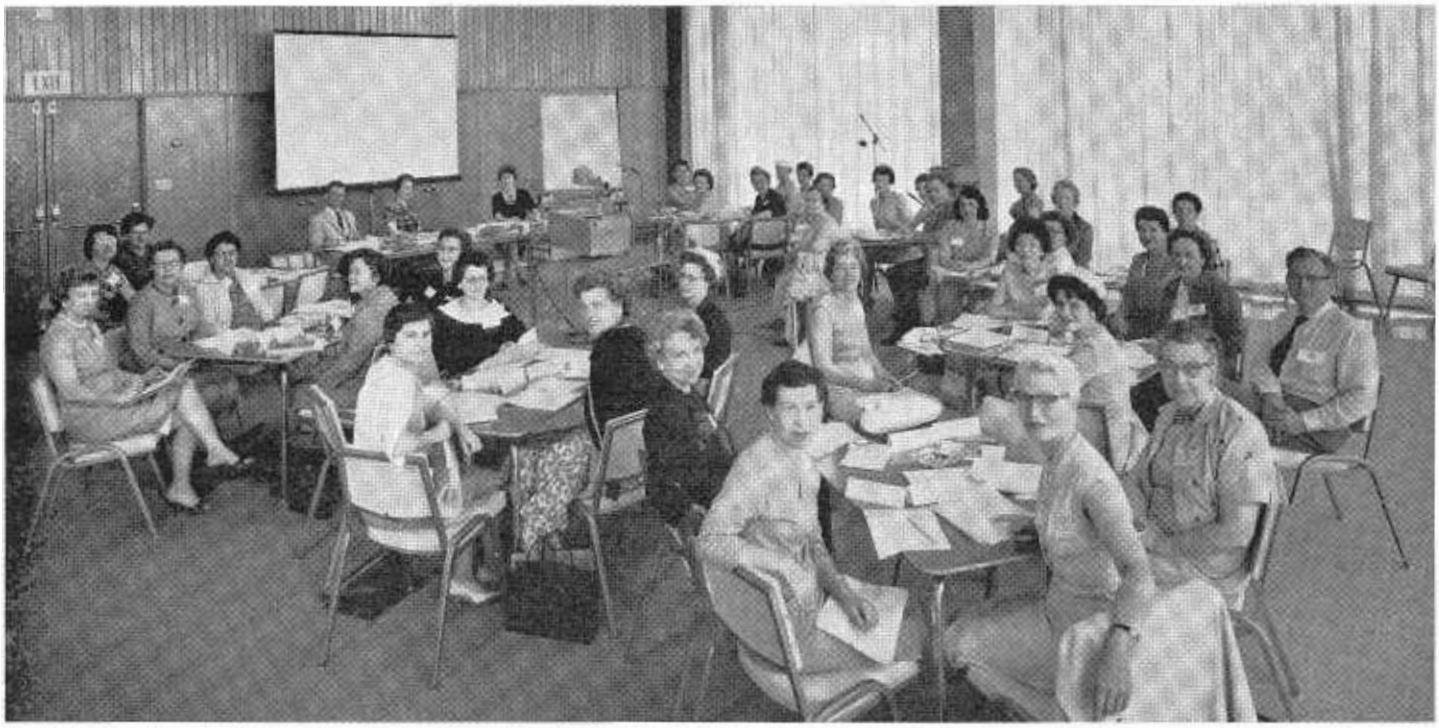
After the EBMUD lines are relocated, the next Walnut Creek channel change work will either be done concurrently with work on the freeway on a State contract or possibly as a separate contract let by the State. The old creek will be connected to the channel change with nominal size pipes upstream and downstream to preserve existing riparian rights.

The co-operative agreements between the State and the Contra Costa County agencies provide essentially that the State will provide all plans and specifications and construct the channel change placing the excavated material in the freeway embankment and bear all costs involved in engineering, construction and right of way acquisition.

The Flood Control District will accept and maintain the channel after its completion.

Substructure work on the Benicia-Martinez Bridge is about six weeks ahead of schedule and the superstructure contract is about on schedule.

PERSONNEL AIDES CONFER ON NEW PROCEDURES



The people in charge of processing the hundreds of thousands of personnel transactions it takes to operate a 14,000-employee organization met in Sacramento on April 6 and 7 for intensive study and discussion of current problems and procedures. The agenda for the personnel clerks, representing all 11 district offices and equipment shops plus several departments headquartered in Sacramento, ranged from compensable injury documents to the new employee appraisal and development program.

Shown at the head table (background of photo) are, left to right, Training Officer Richard T. Soderberg, Personnel Officer Marian Smith, and Supervising Clerk II Evelyn Zazzi. Several other members of the Headquarters Personnel Section are seated at the various tables along with the district, shop and department representatives.

Harbor Freeway Project Wins Bonneroo Award in Los Angeles

On April 19, 1961, 900 highway construction men assembled in the Palladium in Hollywood for the Tenth Annual Bonneroo, a program sponsored by District VII of the California Division of Highways to reward engineers and contractors for high quality workmanship. Frank B. Cressy, Assistant District Engineer, Construction, acted as Master of Ceremonies.

Robert B. Bradford, Director of the Department of Public Works, presented the "Topper" trophy to Ukropina, Polich, Kral and J. E. Haddock, Ltd. for having completed the best highway contract in District VII during 1960. The winning contract was a section of the Harbor Freeway between 0.5 mile south of 190th Street and 0.2 mile north of 124th Street. The winning project was completed on August 5, 1960.

Robert M. Innis, State Resident Engineer in charge of construction on the winning project, was presented a similar award. Certificates of Merit were presented to Henry Rollston and H. L. Benedict, the superintendents for the contractor. Similar certificates were presented to all subcontractors and State personnel who participated in the construction.

The additional winners for the ten best contracts completed in 1960, as announced Wednesday night at the Bonneroo, were:

No. 2.—Ventura and San Diego Freeways: Between Lankershim Boulevard and San Diego Freeway and Between 0.3 mile south of Mulholland Drive and Ventura Freeway. Peter Kiewit Sons' Company, Contractor; F. E. Sturgeon, Resident Engineer.

No. 3.—San Diego Freeway: Between Jefferson Boulevard and 0.3 mile north of Venice Boulevard. Guy F. Atkinson Company, Contractor; S. K. Hoppe, Resident Engineer.

No. 4.—Golden State and San Bernardino Freeways: Between Sixth Street 0.2 mile north of Mission Road and Between Macy Street and Fickett Street. Vinnell Co., Inc. and Vinnell Constructors, Contractor; J. D. Hetherington, Resident Engineer.

No. 5.—Ventura Freeway: Between 0.3 mile east of Encino Avenue and Kelvin Avenue. Oberg Construction Corp. and Oberg Brothers Construction Co., Contractor; K. P. Mock, Resident Engineer.

No. 6.—Arrow Highway: Between Glendora and San Dimas. Boddum Construction Co., Inc., Contractor; B. J. Steele, Resident Engineer.

No. 7.—Valley Boulevard: Between Lemon Avenue in the City of Walnut and Nogales Street in the City of Industry. A-1 Paving Company, Contractor; H. T. Antes, Resident Engineer.

No. 8.—Riverside Freeway: Between 0.4 mile west of Route 2 and 0.1 mile east of Placentia Avenue. Ukropina-Polich-Kral, Contractors; P. Varvis, Resident Engineer.

No. 9.—Palmdale Boulevard: Between 10th Street East and 0.4 mile east of 20th Street East. Frederickson & Kasler, Contractor; T. W. Fera, Resident Engineer.

No. 10.—San Bernardino Freeway: Between 0.2 mile east of San Dimas Avenue and San Bernardino County Line. Matich Constructors and W. F. Maxwell Company, Contractors; R. E. DeGroff, Resident Engineer.

The contracts are rated primarily on the basis of workmanship and excellence on the various major items of work and smoothness of the finished pavement. Job complexity, safety and diligence of contract prosecution are also factors which are considered in judging the ten best projects.

Bridge Bonds Sold for Terminal Island Span

The California Toll Bridge Authority sold $5,000,000 in revenue bonds on April 11 to complete the financing for construction of a suspension bridge over the main channel of Los Angeles Harbor between San Pedro and Terminal Island.

The successful bidder was a group represented by the First Western Bank and Trust Company which offered to purchase the bonds at a net interest rate of 4.8743 per cent per annum. Expiration date of the bonds is July 1, 2000.

The bonds are expected to be delivered to the successful bidder within 30 days.

The only other bidder today was The First Boston Corporation which offered to buy the bonds at a net interest rate of 4.9999 per cent.

The $5,000,000 in revenue bonds will be added to money from other sources to finance the $21,000,000 San Pedro-Terminal Island project. A total of $12,400,000 in state highway funds is available for the project, plus $4,000,000 in state highway user taxes allocated to the City of Los Angeles and Los Angeles County.

The April 11 bid opening was the third time the Toll Bridge Authority had met to receive bids on bonds to help finance the San Pedro-Terminal Island project.

No bids were received last September when $7,000,000 in bonds were offered for sale. Last month the Authority rejected the only bid received on $5,000,000 in bonds because of a legal question concerning a possibility of a conflict of interest.

The Division of Highways in March received low bids totaling $14,008,040 for contracts to construct the bridge substructure and superstructure. Later contracts will provide for construction of roadway approaches and the installation of toll collection equipment.

The bridge will be Southern California's first state toll bridge. The suspension type structure with steel girder approach spans will be 6,010 feet long.

The bridge will have the third longest span in California, exceeded only by the Golden Gate and San Francisco-Oakland Bay Bridges. The main span will be 1,500 feet between towers, and each of the side spans will be 506 feet long.

The bridge towers will rise 370 feet above the water line. Vertical clearance for ships in the main channel will be 185 feet. The bridge deck will be 52 feet wide between curbs, providing four traffic lanes.

Plans call for the start of approach roadway and toll plaza construction next fall, with the entire project due for completion late in 1963.

The bridge will be located near the west end of Terminal Island, slightly north of the present route of the Terminal Island Ferry which it will replace.

On the San Pedro side the approach will extend to Pacific Avenue near Amar Street, crossing over and connecting with Harbor Boulevard near Regan Street.

On Terminal Island, where the toll plaza will be located, the project will end on the south side of Seaside Avenue near Mormon Street.

Commission Approves More F.A.S. Jobs

The California Highway Commission at its May meeting approved eight projects on Federal Aid Secondary County Roads with a total estimated cost of $1,130,000.

The projects approved were:

Lake County—Constructing a new bridge over Putah Creek on Big Canyon Road near Middletown.

Plumas County — Widening 2½ miles of the Bucks Lake Road in Quincy between U.S. 40 and 2½ miles west.

Plumas County—Surfacing of nine miles of Beckwourth-Calpine Road between the Sierra County line and U.S. 40 Alternate near Beckwourth.

Sierra County—Reconstruction of two miles of the Ridge Road between 11 and 9 miles west of Alleghany.

Napa County—Resurfacing sections of the Silverado Trail and Old Sonoma Road near Napa.

Santa Barbara—Widening of a section of Cathedral Oaks Road and construction of a bridge over Maria Ygnacia Creek west of Santa Barbara.

Tuolumne County—Reconstruction of ½ mile of the Tuolumne-Sonora Road east of Sonora. The project includes construction of a new reinforced concrete bridge over Turnback Creek.

Highway Employee Is Co-author of Book

A Division of Highways employee has entered the ranks of published book authors.

He is John Robinson, Associate Editor of *California Highways and Public Works*, whose book "State Parks of California", written with Alfred Calais, Information Officer for the State Division of Beaches and Parks, was published by *Sunset* magazine in April.

In addition to descriptions of each of the State's 170 odd parks and historical monuments, the book also has more than 170 photos, all taken by Robinson, whose articles and photos have previously appeared in many well-known magazines including *Sunset*, *Better Homes and Gardens*, *Family Circle*, *House Beautiful*, *American Home*, *House and Garden*, *This Week* and various newspaper supplements.

Robinson and Calais visited each of the parks to take the photos and get on-the-spot material for their descriptive write-ups.

Their book is published as one of the Sunset Travel Series.

Robinson joined the Division of Highways in 1957. A native of Farmingdale, New Jersey, he served with the U.S. Navy from 1928 to 1948, including a two year tour of duty in Pago Pago, American Samoa from 1939 to 1941.

Following his retirement from the Navy, Robinson studied at the University of California at Berkeley and did free-lance writing and photography.

Robinson is also the author of the series of articles "California Roadsides" currently appearing in *California Highways and Public Works*.

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THEN!

This issue's "Then and Now" page departs from the usual commentary on our changing times, and depicts a piece of the rolling stock of the Division of Highways in the District VI parking lot as it looked before and after it made contact with another vehicle. Robert R. McDonnell of Porterville, Highway Engineering Associate, was proceeding south on U.S. 99 on state business when he saw a pickup coming toward him in his lane going the wrong direction. He made every effort to avoid collision, but could not. Driver of the pickup was killed. McDonnell was wearing his seat belt and was able to walk away from his wrecked car.

NOW!